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Power for Switch Yards

HOT WATER RECLAMATION EQUIPMENT AND SAND DRYING AND TRANSMISSION SYSTEM FEATURES OF NEW CLYDE, ILL. YARDS INSTALLATION OF C. B. & Q. R. R.

ACCOMPANYING THE INDUSTRIAL GROWTH of communities are the ever present and ever increasing demands for greater and better transportation facilities, and with but limited water ways available, expansion of local rail terminals is bound to result until, as in many instances, they extend from the very heart of cities to and beyond outlying suburbs. In general, they comprise the passenger terminal, the freight terminal, the classification yards and the rolling stock supply and repair depots, and while passenger and freight terminals are generally so located as best to serve public necessity and convenience, classification yards, repair shops, round houses and supply stations are placed at more distant and remote points.

Due to the phenomenal growth experienced by practically all lines of business during the past decade with added demands placed upon them by war conditions, the majority of railroads of this country have found themselves seriously handicapped and unable to supply the services they have been called upon to render. As a consequence, much rolling stock has been contracted for and added to existing equipment as quickly as received from the builders, and in order to enable these new cars and locomotives to receive proper care and

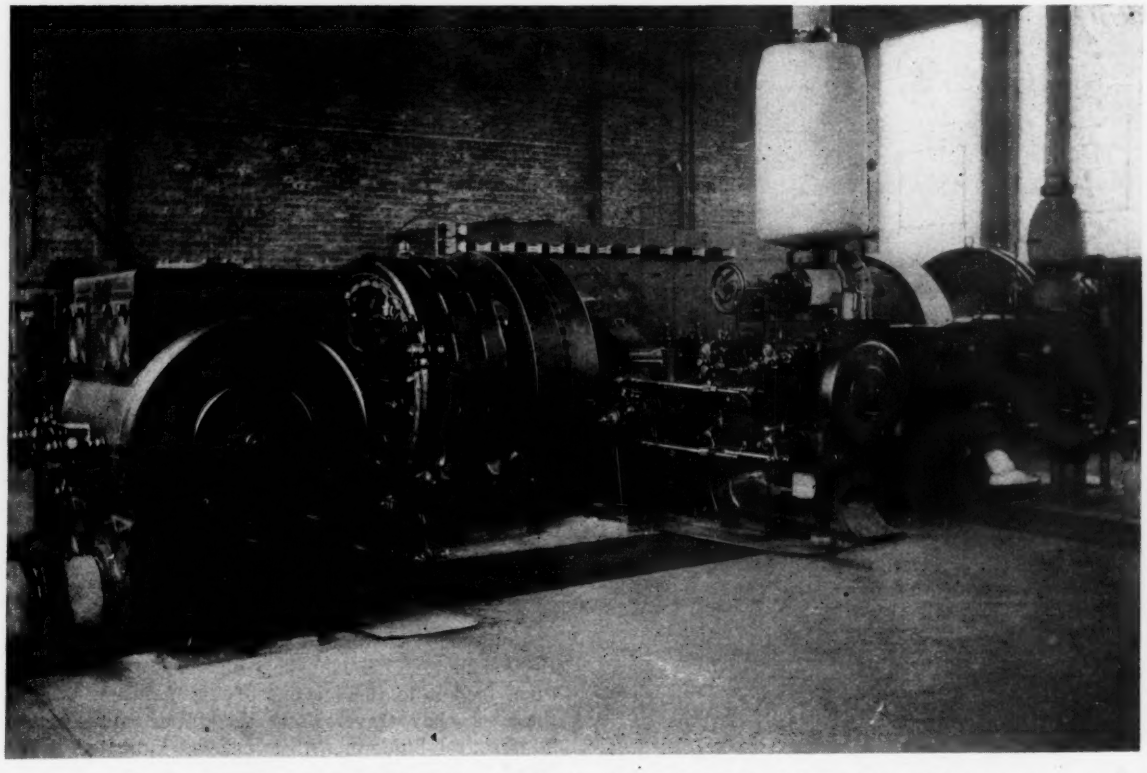


FIG. 1. GENERAL VIEW OF ENGINE ROOM SHOWING GENERATING UNITS AND SWITCHBOARD

attention, terminals have been extended and many new round houses, repair shops and supply stations erected.

Exemplifying this activity on the part of the railroads are the extensions and improvements made to the Chicago terminal of the Chicago, Burlington and

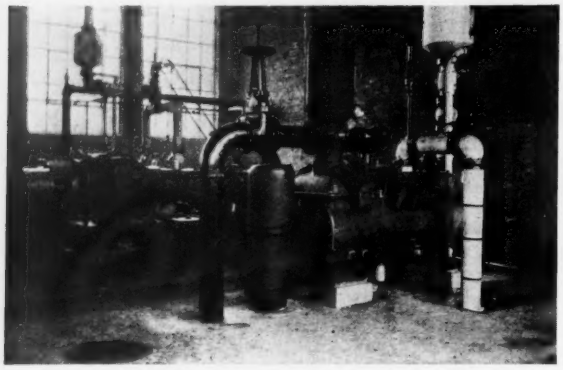


FIG. 2. AIR COMPRESSOR AND FIRE PUMP

Quincy Railroad at Clyde, Ill., where during the past year there have been erected a new 23-locomotive round house, machine shop, supply depot and combined office building and power house, the latter to furnish the

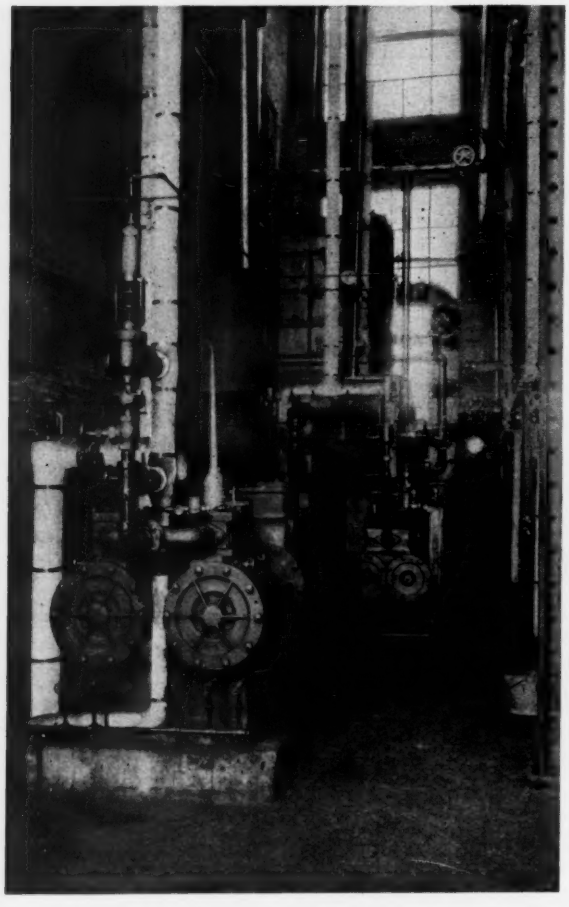


FIG. 3. IN THE BOILER ROOM, SHOWING BOOSTER PUMP, FEED PUMPS AND WEBSTER HEATER

necessary light, heat, power and hot water to these buildings and the adjoining yards.

Fires were first placed under the power house boilers on Dec. 15, 1917.

Except for the combined coal and ash tower adjoining the boiler room on the south side, the building housing the power plant equipment occupies a space of ground of approximately 48½ by 119 ft., and has been so located as to facilitate the ready delivery of fuel and the disposal of ashes by means of the company's own cars run on a special spur track leading to the coal and ash tower. With reference to the combined steam, water, air and electric load, it has been placed as centrally as local conditions would permit, thereby reducing to a minimum transmission line losses and construction costs.

As will be noted by the accompanying illustrations, the power house proper is, except for the basement under the boiler room, a single-story structure, and being of steel, concrete and brick with window and door frames of metal, is fireproof throughout. The boiler room, which has an overall length of about 62 ft., occupies the east

FIG. 4. EXTERIOR VIEW OF CLYDE PLANT WITH TRANSFORMER AND DISTRIBUTION TOWER AT RIGHT

end of the building, while the engine room is between this and the office building at the west end, the office building and power house being separated, however, by means of a brick party wall.

Coal and Ash Systems

A BUCKET CONVEYOR of Link-Belt make has been installed for the handling of coal and ashes. The former, as stated above, is delivered to the plant in cars and from these dumped into the receiving hopper at the bottom of the coal tower which discharges it as required into the buckets of a short cross conveyor operated by a 3-hp. electric motor. The buckets of the cross conveyor in turn, feed it to the buckets of the main conveyor and these, as they travel along the upper runway to the 20-ton steel bunkers with which, as indicated in Figs. 3 and 7, each boiler is equipped.

Ashes are handled in a similar manner. Upon removal from concrete pits below the stokers, they are raked into the buckets of the main conveyor, elevated and dumped into a 15-ton bunker placed between the coal bunkers of boilers No. 2 and 3. From here they are removed at regular intervals by means of a screw con-

veyor connected to a chute which discharges them into cars outside. Main bucket and screw ash conveyors are operated by 5 and 3-hp motors, respectively.

Water Supply

In addition to the water used for power house boiler make up purposes, considerable is required for the cleaning and replenishment of the locomotive boilers at the round house. And in order to insure an adequate and continuous supply, a 200,000-gal. steel standpipe has been erected and is connected to the Chicago city system by means of a private 10-in. main extending from 46th Ave., Chicago, to 56th Ave., Clyde.

From the standpipe the water is delivered to the plant through an 8-in. line and after being heated to a temperature of about 200 deg. F. in a Webster open feed-water heater rated at 1200 hp., it is delivered to the boilers by one of two 10 by 6 by 10-in. Gardner outside-packed duplex feed pumps, which, in the event of a reduction of city pressure, may be assisted by a 14 by 10 by 12-in. Gardner duplex booster pump, installed for that purpose. The scheme of piping employed is such as to insure a high degree of flexibility of operation and with a 2½-in. washout line carried parallel to and interconnected at various points with the 4-in. feed header, these lines or any sections thereof may be used interchangeably for feeding or washing as desired or required by operating conditions.

Steam Generation and Distribution

Although provision has been made in the construction of the building and the layout of the piping for the possible future installation of an additional boiler, the present steam generating equipment consists of three Murray Iron Works water-tube units, each rated at 250 hp. and normally operated under a pressure of 150 lb. gage.

Green chain grate stokers are employed and are actuated by means of a 12-hp. American Blower Co. vertical steam engine. The shafting carrying the grate rod eccentrics is placed parallel to the boiler fronts and is suspended from bearing brackets attached to the ceiling of the boiler room basement as shown in Fig. 7.

Boiler foundations are of concrete and while the rear

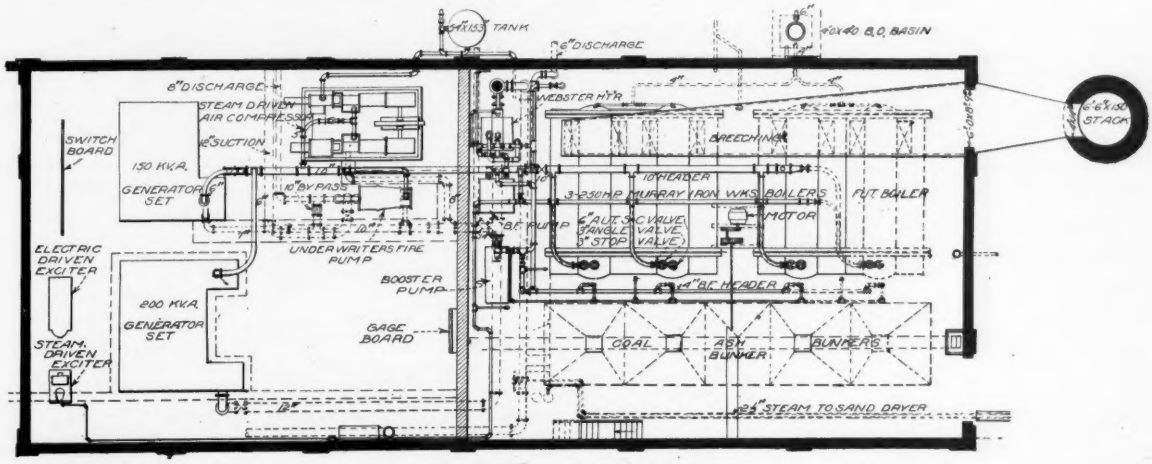


FIG. 5. PLAN OF POWER PLANT

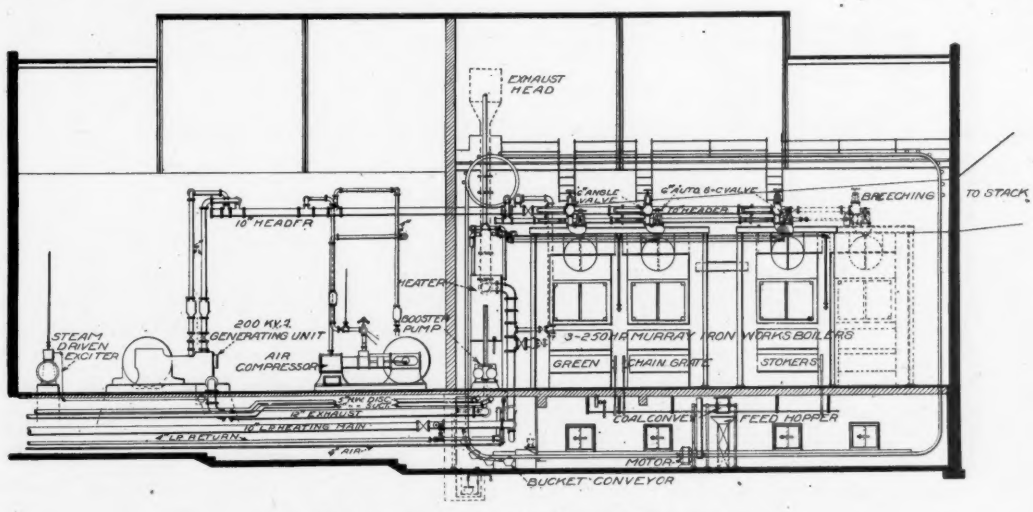


FIG. 6. LONGITUDINAL SECTION OF POWER PLANT

water leg is caused to rest upon a pier built up of common brick on the outside and fire brick on the furnace side, the greater portion of the boiler's weight is sustained by a framework of structural steel through the medium of suspension rods. Inclined ignition arches are employed and the body of the bridge wall is of common brick, faced and capped with fire brick and tile in the manner indicated in Fig. 7, which also illustrates the form of combustion chamber used. The inclined fill, which consists of a base of dirt, is covered by a slab of concrete carrying a single course of fire brick.

Products of combustion are cared for by a steel breeching carried along the rear of the boilers and connecting with a reinforced concrete stack placed directly outside of the plant and having an internal diameter of 6 ft. 6 in. and an overall height of 150 ft. The breeching dimensions at the stack entrance are 4 by 14 ft., providing about 0.056 sq. ft. of sectional area per ultimate rated horsepower of the boiler plant.

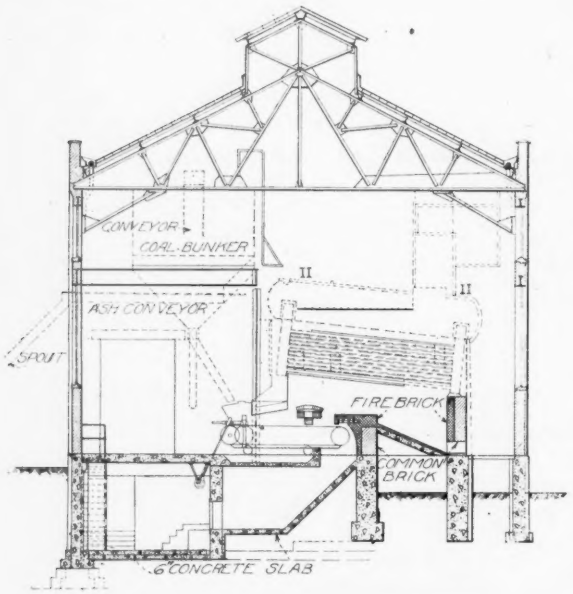


FIG. 7. CROSS SECTION OF BOILER ROOM

Steam, as stated before, is normally generated at a pressure of 150 lb. gage. Ordinarily this is delivered to the engines, pumps and heating systems through a 10-in. main header connected to the individual units by 6-in. leads, each of which carries an automatic stop and check valve and an angle valve both of like size. However, to meet any emergency which might arise and to insure continuity of service, there has been installed a 6-in. auxiliary header with independent 3-in. leads connected to the main outlet by a 3-in. stop valve and attached tee placed between the 6-in. automatic stop and check, and the angle valves. The scheme of connections employed is as indicated in Figs. 5 and 6, which also show the general layout of the main high-pressure steam lines in the engine room; here, as will be seen, the main header is also 10 in. in diameter and the engine leads and fire pump and compressor leads each 6 and 4 in., respectively.

Attached to the end of the engine room header is a drip pocket connected through a ¾-in. line to a trap in the basement of the boiler room.

Other purposes for which high-pressure steam is utilized are the forcing of newly made fires under the locomotives in the round house and the heating of the sand drier coils, although for the latter service the pressure is reduced to 100 lb. by means of a 3-in. reducing valve.

All high-pressure apparatus is well drained, the condensate obtained being cared for by individual Boylston traps which discharge directly into the heater. Returns from the heating system are also returned to the heater, an 8 by 12 by 12-in. simplex Marsh vacuum pump having been installed for that purpose.

All engine room exhaust lines are carried in concrete trenches covered by iron floor plates. Those serving the 120-kv.a. generating unit and the 18 by 10 by 12-in. duplex Underwriters' fire pump are each 7 and 5 in., respectively and terminate in a 10-in. line, which, near the boiler room wall, is joined by another 8-in. line from the air compressor and remaining pumps, and is there increased to 14 in. This is then extended into the boiler room where by means of a tee, one side of which is attached to a 12-in. line from the 200-kv.a. generating unit, it is joined to a 16-in. main connecting with the heater. The steam, however, before entering the heater is passed through a 16-in. oil separator and that not required for heating is caused to escape to the atmosphere through a 16-in. exhaust head located on the roof of the boiler room.

Engine Room Equipment

Views taken in the engine room and showing the main generating units, the fire pump and the air compressor are shown in Figs. 1 and 2. Electric current is generated at 440 v., three-phase, by two units, one of which is rated at 120 kv.a. and direct connected to a 16 by 16-in. Ideal engine, while the other, a 200-kv.a. machine, is driven by a 16 and 28 by 17-in. cross compound Fleming 4-valve engine of Harrisburg Foundry & Machine Co. make.

Provision has been made for the installation of two exciter units, one engine-driven and the other motor-driven; but due to inability to secure the engine-driven set up to the present time, the latter, which is rated at 25 kw., 125 v., is depended upon exclusively for the excitation of the main generator fields. For starting purposes this exciter is temporarily belted to the Fleming engine and as soon as the line voltage has been built up sufficiently to enable the generator to carry load, the exciter motor is thrown onto the line and the belt removed.

The switchboard, as shown in Figs. 1 and 5, is placed directly back of the main generating units and consists of seven slate panels with necessary instruments, oil switches and rheostats; a Tirrill voltage regulator is mounted at the south end of the board.

Remaining engine room equipment consists of an 18 by 10 by 12-in. duplex Underwriters' fire pump of Worthington make and an air compressor for the operation of pneumatic tools, turn tables and the sand transmission system. The latter, a product of Ingersoll-Rand

Co., is of the two-stage type with 14-in. steam cylinders, 16-in. stroke and 14¼ and 22¼-in. air cylinders. It is under automatic control and delivers air at a pressure of 100 lb. through a 5 in. discharge line, to a 50 by 153-in. C. B. & Q. standard storage tank, located directly outside of the plant.

Hot Water Reclamation

With the comparatively great number of locomotives brought into the round house for cleaning and repair, large volumes of water are handled and in order to conserve as much as possible of the heat contained in that removed from the locomotive boilers, a reclaiming system has been installed. The details of this, which consists of a brick catch basin, a concrete settling basin and a large concrete reservoir, are shown in Fig. 8.

Water taken from the boilers is first discharged into the catch basin whence it flows by gravity into the settling basin and from there into the main reservoir. It is then returned to the round house for re-use as required, by means of an American centrifugal pump directly coupled to an Allis-Chalmers three-phase induction motor. The suction of the pump is connected to a 6-in. line carried to within 2 ft. of the bottom of the reservoir, at which point there is attached, through the medium of a swing joint, a float operated pipe built up of No. 22 galvanized iron and fitted with a perforated cap through which the water is drawn. The float used is of the same material as the spiral pipe and is flat riveted and soldered and made perfectly water tight; it has an external diameter of 24 in. and a height of 8 in. and is attached to the perforated cap by a flexible link joint.

As shown by the detail drawings, Fig. 8, the spiral pipe is attached to the 6-in. ell of the swing joint by means of a nipple riveted to the pipe and screwed into the ell.

This drawing also illustrates the construction of the basins and the reservoir. The catch basin, which has a depth of 9 ft. and an internal diameter of 6 ft., consists essentially of a supporting mat of concrete reinforced with ½-in. square bars, 9-in. brick side walls and a 6-in. thick cover, also of reinforced concrete and fitted with a 24-in. manhole.

Both settling basin and reservoir are of concrete construction throughout, reinforced where necessary. The former, with overall dimensions of 18 by 10 ft. and a height of a trifle more than 9 ft., is divided into four communicating compartments, each 3 ft. 6 in. by 8 ft., and 8 ft. high. Water entering the basin passes from the first compartment to the second through a 2-ft. opening at the bottom of the first separating wall, and after having reached a sufficient height is caused to flow over a 4 ft. wall into the third compartment from where it continues through another 2-ft. opening in the third wall into the fourth compartment. A pipe with opening about 5 ft. from the bottom of the basin conducts the water from here to the reservoir which it enters at the top.

Of cylindrical construction and with dished heads the reservoir has an internal diameter of 30 ft. and an overall maximum depth of 23 ft. and is designed to hold approximately 95,000 gal. of water, although anything in excess of about 79,000 gal. is carried to the city sewers through an 8-in. overflow pipe placed within 3 ft. of the ground line.

Additional heat is provided by the exhaust steam from the round house which is delivered to the reservoir through a 3-in. line, the outlet of which extends to within about 2 ft. of the floor line.

Sand Drying and Transmission Equipment

One of the novel uses to which steam and compressed air are placed is in the drying and transmission of sand. This is delivered to the Clyde yards in open cars and by means of a portable clam shell crane is transferred to the hopper of the drying house from where it is allowed to flow in fine streams over and through driers, consisting of a series of 1¼-in. pipe carrying live steam at boiler pressure. Due to its intimate con-

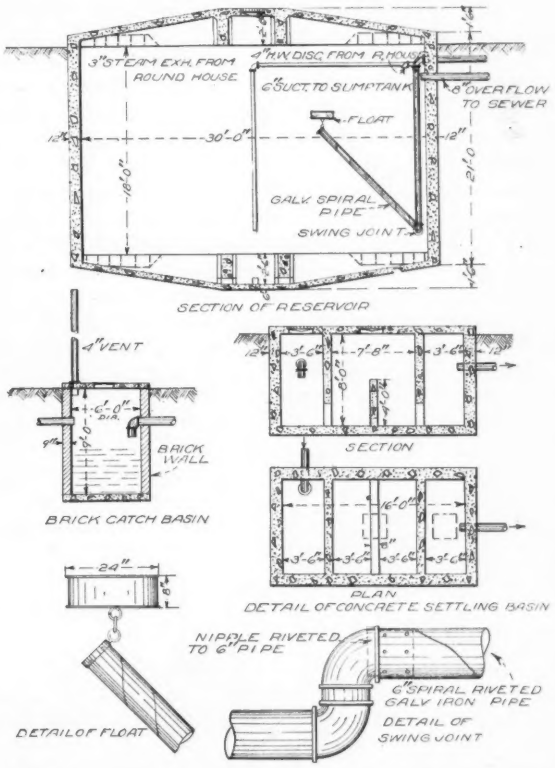


FIG. 8. DETAILS OF HOT WATER RECLAMATION SYSTEM

tact with these hot pipes, the contained moisture is entirely removed. The sand is then deposited in a receiving hopper from the bottom of which it is picked up by a jet of air at a pressure of 100 lb. and forced through a 950-ft. 3-in. line to a storage hopper which receives the sand at about 70 ft. above the ground line. Due to the cutting action to which the inside walls of this pipe are subjected, all sections and fittings are of chilled steel, and to reduce the internal resistance of the line to a minimum, bends of 56-in. radius are employed.

Electric Distribution

Current generated at the Clyde Yards plant is distributed over a territory extending from 52nd Ave. on the east to the village of Berwyn on the west, and is

utilized not only at the power house, round house, machine shop and store rooms, but also for the illumination of the freight yards, stock yards and cinder pits and the operation of the block towers. It is delivered to the bus bars on the switchboard at 440 v. and for all circuits except those within the power house and surrounding grounds and buildings is stepped up to 2300 v. by means of a bank of three transformers mounted as shown in Fig. 4 on a steel tower directly outside of the plant. At local distribution points it is again stepped down to 440 v. for power and 110 v. for lighting.

Operation of the Clyde Yards plant is in charge of L. G. Kunzer, mechanical expert, and it is due to courtesies and assistance extended by him and W. G. Glover, of the J. R. Kehm Co., heating contractors, that the preparation of this article was possible.

Unstable Water Lines in Heating Boilers

CAUSES CONTRIBUTING TO SUCH CONDITIONS AND REMEDIES WHICH MAY BE APPLIED. BY CHARLES L. HUBBARD

ALTHOUGH a majority of store and office buildings in large cities are provided with high-pressure boilers for power service, there are many installations of low-pressure heating boilers in schools, churches, apartment houses, clubs, libraries, stores and office buildings of comparatively small size away from the main business districts. While the larger of these will be equipped with horizontal tubular boilers there will be found a considerable proportion of sectional cast-iron heating boilers, a type particularly susceptible to a fluctuating or unsteady water line. This is an especially annoying condition for the engineer or fireman in charge, because it makes it impossible for him to leave the boiler room, except for a few minutes at a time when forcing the boilers at all, and again, when the water leaves the glass there is no way of knowing how much has gone out of the boiler or just what conditions are inside. A fluctuating water line may prove simply annoying to

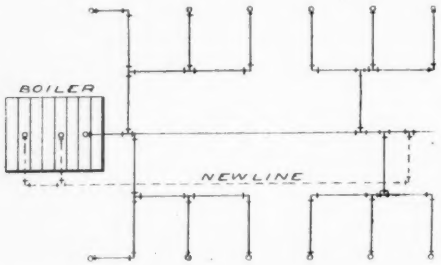
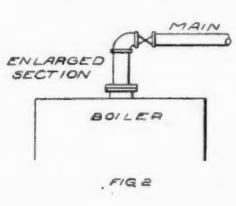


FIG. 1. SHOWING METHOD OF REINFORCING A STEAM MAIN

those in charge, or it may result in more or less serious damage, depending upon the type of boiler and the cause of the internal disturbance.

While an unstable water-line sometimes occurs in tubular boilers it is more likely to be found in cast-iron boilers of the sectional type, owing to the smaller steam space and the method of connecting the sections in a majority of makes. Furthermore, this condition is most frequently found in new plants which have not been in operation for any length of time. In cases of this kind, chances are, the difficulty is caused by grease or oil in the boiler, which comes from the oil used in tapping the radiators and boiler and from the lead or grease used in making up the pipe joints. Conditions of this kind are also made worse in many instances by the presence of core sand from the castings which has not been thoroughly removed, or by building sand which has found its way into unplugged ends of piping and radiator tappings in careless handling about the works. When the boilers are fired up and this foreign matter is brought back by the condensation it forms a soapy substance which causes foaming or priming, thus breaking the surface of the water into a fine spray and allowing it to be carried over into the steam mains. This not only lowers the water level in the boiler but still further aggravates the trouble because water in the steam piping always causes rapid condensation, thus producing an inequality of pressure. This in turn tends to hold the condensation back at certain points, thus preventing it from returning to the boiler as would be the case under normal conditions. The combined effect of foaming and the holding back of the condensation in the piping will soon draw a considerable portion of the water out of a cast-iron boiler in which the storage space is relatively small.

This action will not be so sudden in case the returns are sealed, because the return system, in effect, forms a part of the boiler, and the contained water is much



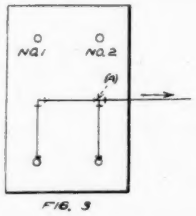


FIG. 2. ENLARGED VERTICAL BOILER LEAD

FIG. 3. ILLUSTRATING SIPHON EFFECT OF INCORRECT STEAM PIPING

greater than with a system having dry returns where all of the water is in the boiler proper. The general result, however, is the same in either case, although slower in the first. Temporary relief from foaming may be had by opening the fire doors and checking the fire. If this does not produce the desired results promptly, it may be necessary to cool off the furnace still more by covering the fire with fresh coal, or better, with damp ashes. As soon as the pressure drops sufficiently, due to cooling of the furnace, foaming will have ceased and the water which has been carried over will return to the boiler by gravity. A permanent remedy, however, can only be secured by thoroughly cleaning the boiler of all foreign matter. The simplest way, and also the slowest, is to blow off the boiler at frequent intervals and add fresh water. It so happens, however, that oil

and other organic matter which tends to produce foaming floats on top of the water, and for this reason results may be considerably hurried by connecting up a temporary surface blowoff for use until the boiler has become thoroughly cleaned. If there is a plugged opening in the top of the boiler, this may be utilized, and if not, the safety valve may be removed. If the end of the pipe is extended into the boiler to a point on a level with, or just above, the surface of the water, the outward rush of steam through it will pick up some of the water and a considerable portion of the scum. With this arrangement, the method of cleaning the boiler is to close the valve in the steam main and build a wood fire, slowly raising the pressure to 8 or 10 lb., then opening the surface blowoff and discharging a portion of the water which will carry off the lighter impurities. Refill the boiler, add just sufficient fuel to raise the pressure again to 8 or 10 lb.; draw the fire, then open the lower blowoff and discharge all of the water. This will clear out the sand and heavier impurities which have settled to the bottom.

Let the boiler cool, then fill with fresh water and make a trial of its operation. If it still gives trouble, repeat the process until you are sure the boiler is clean. If the first blowing out does not remove all of the oil, it is a good plan to put in a solution of sal soda and

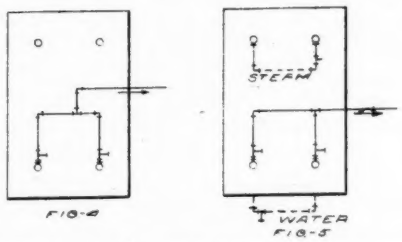


FIG. 4. TYPICAL STEAM CONNECTIONS FOR AVOIDING SIPHONING EFFECT

FIG. 5. SHOWING EQUALIZING PIPES FOR STEAM AND WATER CHAMBERS

fire the boiler for several hours before making the second trial.

Another method is to connect the surface blowoff with the top of the boiler and omit the extension piece leading down to the water level. Carry the pipe to some convenient point for discharge, taking care not to drop the end much below the top of the boiler, so as to produce siphonage. Fill the boiler nearly full, and build a wood fire. When the water begins to boil, slowly add more until it boils out of the surface blowoff pipe, carrying the oil and scum with it. Keep this up until the water comes clear; then draw off down to the normal water line, close the surface blowoff, raise the pressure to 10 lb., draw the fire, and empty the boiler under pressure as before. If this proceeding does not produce a steady water line under normal working conditions, then look for faults of construction or piping.

It may be said at this point, however, that the work of cleaning the boiler will not be lost, even though it does not prove to be the cause of the unstable water line. Oil in a system of heating produces other bad results, and every new system should be thoroughly cleaned of oil and other debris before being put in operation.

If cleaning the boiler fails to remove the difficulty, the next step is to examine the piping, which may be at fault either in regard to size or method of connection. If the supply mains are too small, there will be a resulting drop in pressure at the ends most remote from the boiler, which difference in pressure will allow the water in the return drops to rise in order to balance it. As a drop of 1 lb. in pressure will cause a rise of only about 2 ft. in the vertical drops, the amount of water forced out of the boiler will be comparatively small

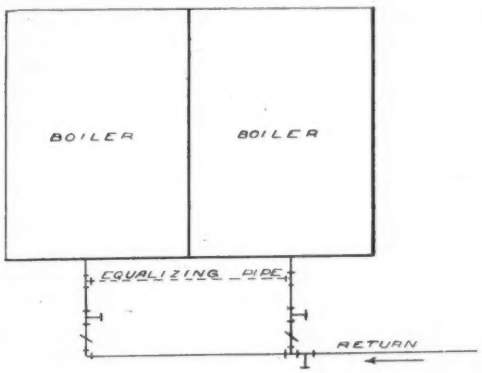


FIG. 6. LOCATION OF EQUALIZING PIPE BETWEEN RETURNS IN BATTERY OF BOILERS

unless indirect stacks are hung so close to the water line that the water in the returns will back into them. Under these conditions a rise of a few inches, after the water has reached the stacks, will drain a considerable amount out of the boiler. This will be especially noticeable in the case of cast-iron sectional boilers where the water capacity is comparatively small.

Another effect of too small mains, especially in systems having an overhead or dry return, is the holding

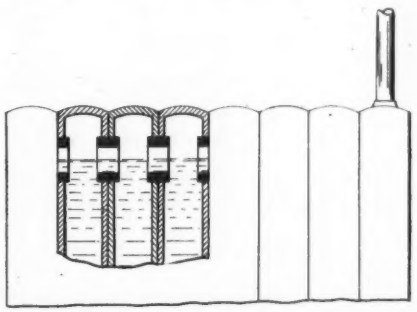


FIG. 7. SHOWING INTERIOR CONSTRUCTION OF SECTIONAL CAST-IRON BOILER

back of condensation in certain parts, due to the unbalanced pressure, which, in time, will remove a considerable amount of water from the boiler. The only remedy in a case of this kind is to enlarge the mains or supply additional feeders to certain sections of the system.

In general, it will be less costly to let the original piping remain as it is and run one or two extra pipes from the boiler so as to relieve the conditions, as indicated by the dotted lines in Fig. 1. In doing this, it will be less expensive to carry the new piping to sections nearest the boiler.

Sometimes the backing up of water into the overhead piping can be entirely removed by the addition of a few siphon loops for draining certain points without admitting steam at full pressure into the piping to be drained. The holding back of water in this way is due to short-circuiting of steam from some point nearer the boiler, which tends to prevent the condensation from more distant points, where the pressure behind it is lower, from draining back by gravity.

Sometimes the whole trouble comes from a contraction at the boiler outlet or nozzle, which so raises the velocity of the steam as it leaves the boiler that it picks up some of the water in the form of a spray and carries it over into the mains. Cases of this kind are remedied either by enlarging the outlet or adding another and connecting it with the main a short distance from the boiler.

It is good practice in new work to make the vertical riser connecting with the boiler two sizes larger than the horizontal main with which it connect, as in Fig. 2. This reduces the velocity until the steam reaches a point sufficiently far away from the surface of the water to prevent the carrying over of spray.

Sometimes, in cases where two boilers are connected up in battery, the water will stand considerably lower in one than in the other, or it may entirely disappear from one glass while the other shows the boiler to be gradually flooded. Conditions of this kind may be due to one of two reasons or a combination of the two.

When the steam connections are as in Fig. 3, there is danger of a siphon effect on boiler No. 2; that is, if the piping is small and the steam velocity high, the fitting, A, will act as an ejector and tend to draw water out of the boiler in the form of a fine spray. If the condensation returns to the boilers by gravity and there are no checks on the individual returns to the boilers, matters will tend to neutralize themselves, as the slightly lower pressure in boiler No. 2 will draw in water from

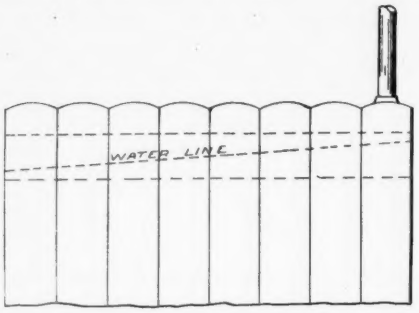


FIG. 8. SHOWING FLUCTUATION OF WATER LINE

the return a little faster than boiler No. 1, and so make up the deficiency. If the condensation is returned by a pump or there is a check in the return to each boiler, the water will gradually leave No. 2 and accumulate in No. 1. Cases of this kind may generally be overcome by connecting the main between the boiler leads, as in Fig. 4; by using a header of such size that the velocity will be greatly reduced; or by adding equalizing pipes both above and below the water line, as shown by the dotted lines in Fig. 5.

When checks are used in the return to each boiler, the water may gradually leave one and accumulate in the other, even though the steam connections are apparently all right. This is because one check may open more easily than the other and the return water will naturally take the path of least resistance. This may be remedied either by removing the individual checks and substituting a single large one in the main return, or by adding an equalizing pipe inside the checks, as in Fig. 6. When a single large check valve is used, it should be placed pretty well over on the side in order that it will open more easily, otherwise the resistance will raise the water line in the returns sufficiently to cause trouble if there are indirect stacks in a low basement. Although a valve in this position will allow

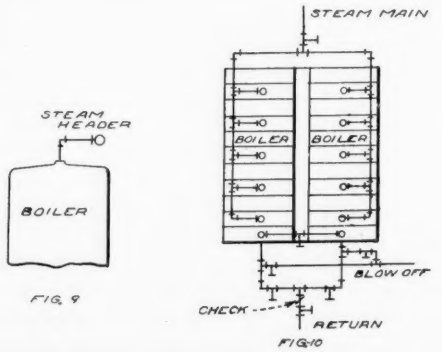


FIG. 9. METHOD OF CONNECTING EVERY OTHER SECTION WITH STEAM HEADER

FIG. 10. SHOWING TYPICAL STEAM AND RETURN CONNECTIONS AT BOILER

water to back through it slowly, it will prevent any sudden rush out of the boiler.

While looking over the piping, the gage glass connections should also be inspected, as under certain conditions these may have much to do with the steadiness of the water line, especially in case of a cast-iron sectional boiler. The rapid circulation of water up the water-legs of a boiler of this type, and to a certain extent in a round boiler, will tend to draw water out of the glass while there is still an ample amount in the boiler itself. When the bottom of the gage is connected into a return or where there will be a rapid flow across the end of the connection, the water is liable to be drawn out of the glass in the manner mentioned above. For this reason, care should be taken to connect the lower end of the glass with some point where the circulation is sluggish; this will depend largely upon the design of the boiler and must be determined in each particular case. This is mentioned more especially as a point to be looked into in case the boiler acts in a faulty manner and the cause seems to be somewhat obscure.

In a general way, the various causes of an unstable water line mentioned thus far may apply either to a cast-iron or return tubular boiler, although they may be more marked in case of the former, as already noted.

The usual type of sectional cast-iron boiler, however, is especially susceptible to this condition and great care should be taken, in making the steam connections, to avoid it. The principle of construction in this case is illustrated in Fig. 7, being made up of vertical sections connected at top and bottom with nipples. This particular design affords a limited steam space and a some-

what contracted opening between the sections for the passage of steam from one to another. Suppose, for instance, in Fig. 7, the steam is all taken from an outlet in the rear section (an extreme case). It is evident that in passing from one section to another, toward the rear, the steam gains in volume and therefore in velocity, as the opening through the nipple above the water line is the same in each case. The effect of this is to draw the water along with it, thus raising the level in each successive section until the surface occupies the approximate position shown in Fig. 8. By the time the last opening is reached, it is so choked that the water is broken into a spray and a certain amount carried over with the steam into the main. Again, the front section has a much larger heating surface than the intermediate ones, hence as evaporation takes place much more rapidly here, a higher steam pressure exists, which tends to force down the water at the front of the boiler and raise it at the rear, thus increasing the effect already noted above. The remedy in this case is evidently to increase the number of outlets so as to limit the number of sections through which the steam must pass in order to reach the discharge nozzle. By connecting with every other section the flow from intermediate ones will be in both directions so that all accumulative effect will be eliminated. This is practically changing the boiler into one of the "drum" type, in which connections are made with half of the sections instead of all of them, as is the case with the regular drum boiler of this type. This arrangement is shown in Fig. 9, and in some ways is preferable, owing to the greater flexibility as compared with the arrangement where short, straight nipples enter the bottom of the drum.

The arrangement shown in Fig. 9 is that recommended for new work, and in some cases it may be best to carry it out on a boiler already installed, if conditions are especially bad and point to this as a cause.

In general, however, where the piping is already in place, it may answer all purposes to remove the existing plugs in the top of the boiler and make short connections with the main or its branches where most convenient.

A typical piping arrangement at the boilers which should do away with all possible difficulty in the way of a positive return and a stable water line is shown in Fig. 10.

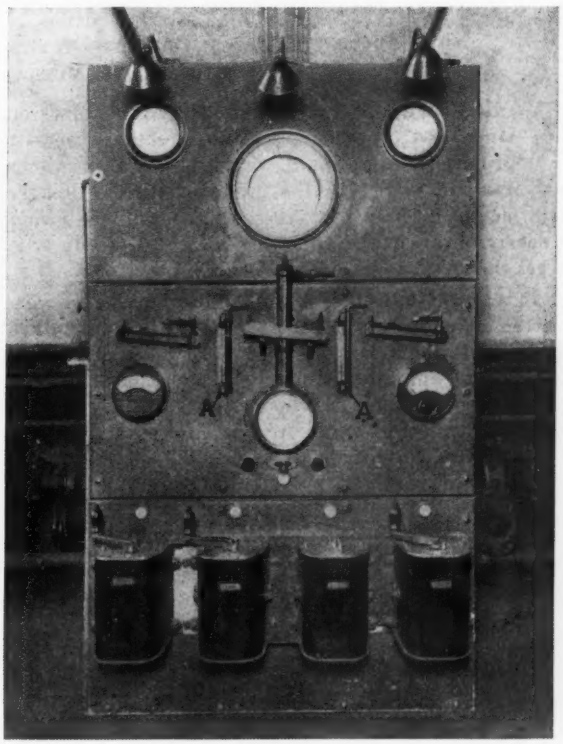
IN THE WEEKLY report on the production of bituminous coal compiled by the Geological Survey, Department of the Interior, April 20, 1918, it is stated that the production of bituminous coal increased 1,600,000 net tons or over 17 per cent during week ended April 13 compared with the preceding week. The total production of bituminous coal (including lignite and coal made into coke) is estimated at 10,947,000 net tons, an average production per working day of 1,824,000 net tons, compared with an average of 1,777,000 tons for the past year and 1,680,000 tons in April, 1917. Production for the first two weeks of April is estimated at 20,264,000 net tons, approximately 19 per cent below the production of the same period of March, 1918. The total production of beehive coke is estimated on the basis of railroad shipments at 672,000 net tons, an average per working day of 112,000 net tons.

Firing Boilers by Brain Power

CONDITIONS REGULATED FROM A SWITCHBOARD TO GENERATE THE REQUIRED AMOUNT OF STEAM WITH A MINIMUM OF COAL. MUSCLE REPLACED BY REASON

IN a certain plant which represents the best modern knowledge and methods, the intention has been to reduce the labor of handling coal to a minimum, having the coal and ash-handling machinery operated by controllers on a switchboard, and to keep the boiler operator informed of exactly what his plant is doing by means of adequate equipment of instruments, conveniently arranged at one point. Firing is thus made an art, and the men are picked for mental ability rather than capacity to wield a shovel.

Coal from bottom dump cars is dropped into track hoppers, then raised by flight conveyors to the crusher,



FRONT OF BOILER CONTROL SWITCH AND INSTRUMENT BOARD

from which bucket conveyors lift it to bunkers in the top of the boiler house. From these bunkers, the coal feeds by gravity to the stokers.

Refuse from the fuel is passed through clinker grinders, which are a part of the stokers, into ash hoppers, and dumped into railroad cars.

For control of each boiler an instrument board is located at the most convenient point, and equipped with a steam flow meter, to show output, two pressure gages, tachometers showing the stoker speed and the corresponding thousands of pounds of coal fed per hour, indicators to give the pressure from the motor-driven blowers, whose speed is governed by controllers at the board, draft gages for guiding in the setting of the dampers, which are controlled by a switch on the board,

and last a CO_2 machine whose record indicates, in part, the operator's success in handling his controls. Inspection doors in the setting further guide the boiler operator in adjusting conditions to requirements, and a recording thermometer gives the final result of heat escaping to the chimney. To take care of inequalities of fuel and variation in the fuel bed, small dampers are built into the stoker, enabling the operator to vary the rate of combustion at different points in the furnace without changing the rate as a whole. The average rate is varied by stoker feed, draft regulation and speed of the clinker grinder.

By these provisions, one operator is enabled to care for two boilers rated at 2500 b.hp., which are used to supply steam to a 25,000-kv.a. turbine unit.

It is found that mechanical soot blowers give better cleaning than hand operated, and reduce costs. The water surfaces are kept clean by removing sediment and scale-forming material from the water before it enters the boiler, reusing condensation, and distilling the make-up water, which is reduced to 1 per cent. This reduces the labor for internal cleaning and the spare boilers required, practically does away with tube failures and renewals, and nearly eliminates blowing down with its resultant loss of heat and make-up water.

From coal weights and analysis, and the metering of water and steam, it has been determined that the average thermal efficiency is maintained at 5 to 7 per cent of that for best conditions at the best load. Data is taken largely from an article in The Sibley Journal of Engineering.

Transmitting Crosshead Motion to the Indicator

DETAILED DIRECTIONS GIVEN FOR MAKING REDUCING MOTION. BY C. E. ANDERSON

EVERY engineer who has indicated several different kinds and types of engines where there were no provisions made on the engines for transmitting the crosshead motion to the indicator card, will agree with me that it is a troublesome job sometimes (which is nearly always) to rig up some kind of device in order to get the crosshead motion to the indicator.

It is not quite so difficult if one has a reducing wheel (as the reducing wheel will take care of any length of stroke) with the indicator. But in cases where you have no reducing wheel or the one you have happens to break or get out of order (just when you need it most), it will sometimes tax the engineer's ingenuity to rig up a device for reducing the motion from the crosshead to the indicator.

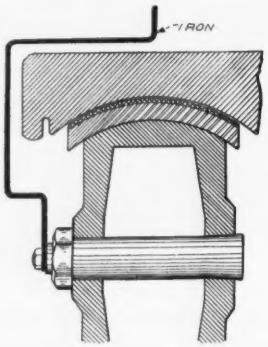


FIG. 1. BENT IRON ATTACHED TO CROSSHEAD

It is not a very difficult proposition if one has the tools and material on hand with which to do it. Most plants that call on outside help when they are in trouble or to indicate their engines, are poorly equipped in the line of tools and material.

I remember one plant I was called to, one rainy night, some time ago. The engineer 'phoned me to bring my indicator only, as he thought that the eccentric had slipped and it was just a case of resetting the valves. The engine would not carry the load in the present condition. The first thing I looked for was some means for transmitting the crosshead motion to the reducing wheel; of course there was none.

The engine in question was a large Green Wheelock cross compound, driving directly on its main shaft a 1000-kw. d.c. generator. The indicator cocks on this engine were located in the top of the cylinder instead of at the sides, as is the usual custom of engine builders' practice nowadays.

In order to get the indicator cord in line with the indicator and also parallel both ways with the piston rod, it was necessary for us to bend a piece of iron, ½ in. thick by 1½ in. wide, into the shape shown in Fig. 1. There were no drills or drill press around the plant. In order to get a hole in one end of this iron, I heated it in the boiler furnace and punched a ½-in. hole in the end by means of a ½-in. bolt, using the bolt for a punch; a ¾-in. nut underneath served as a die.

After clamping this flat iron into the required position on the crosshead pin, adjusting the indicator and placing a sheet of paper on the drum, we were ready to take a card.

We started the engine without a load and ran it up to speed, hooked the indicator cord to the flat iron piece and everything looked all right.

I was just going to take a card when smash went the reducing wheel. The cord had jumped out of its groove and tangled up around the shaft at the base of the reducing wheel. This shortened the cord, and when the limit was reached, of course the engine gave the cord a violent jerk which broke off the pin that the long cord wheel revolved on.

This put the reducing wheel out of commission completely. I had to make some kind of reducing motion and make it quickly, as the shutting down of this engine placed half of the plant out of commission.

I inquired of the engineer if he had any tools such as a hacksaw, files, a few drills and a breast drill. He replied in the negative; all he had was an 8-in. and a 12-in. monkeywrench with a 14-in. Stillson wrench thrown in for good luck.

But he informed me that the company's tools were under the vise bench in one corner of the engine room.

I went over to the bench and here is what I found. A 36-in. Stillson wrench with the handle as crooked as a dog's hind leg, which evidently had been used in conjunction with a long piece of pipe some time or other to give it added leverage; a 16-lb. sledge with the handle broken off short and a heavy cold chisel about 18 in. long made up the full quota of company tools.

I knew I could not possibly make the reducing rig that I had in mind with this conglomeration of junk, so I set the valves on the engine by the builder's marks and it carried the load fairly well.

A better adjustment of the valves was made the next day. I had purchased a new reducing wheel, so I could take cards with the old rig on the crosshead that we had made the night before.

I made up my mind that I was not going to be caught like that again if I could help it, so I built a sort of flexible universal reducing motion which I had had in mind for some time. This apparatus is very handy, especially for center crank engines of the high-speed type. These engines generally have the indicator cocks on the top of the cylinder.

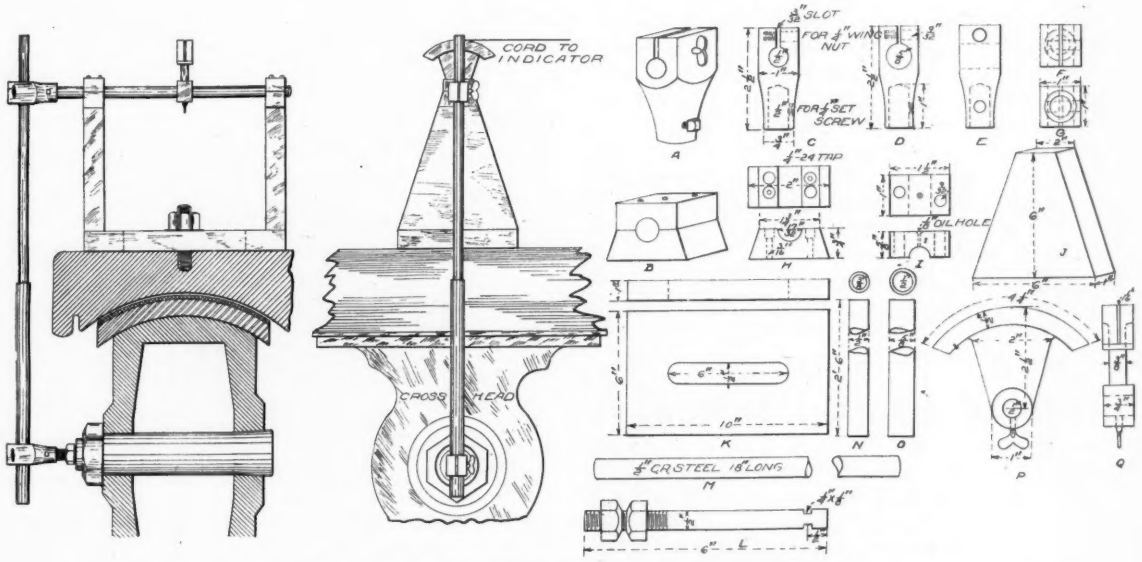


FIG. 2. DETAILS AND ASSEMBLY VIEWS OF REDUCING MOTION

The apparatus consists of a wooden base and 2 sides made of maple wood, marked K and J in the sketch. The base is 6 in. wide by 10 in. long and 1 in. thick. Through the center of this base is cut a slot 1 in. wide and 6 in. long, the ends of the slot being equal distances apart from the ends of the base. This is made for a bolt to pass through in order to clamp the apparatus rigidly to the engine by means of a nut and washer on the upper end of the stud or bolt.

The sides are 6 in. long by 6 by 1 in. at the bottom, tapering up to 2 by 1 in. at the top. On the top of these sides are placed the bearings, one on each side and fastened to the sides by means of wood screws. These bearings are made in 2 parts of ordinary red fiber board such as is used on electrical work; these give excellent service, being strong and light, and have excellent wearing qualities.

Parts marked B illustrate the bearing as assembled, while H and I are the detail sketches, H being the lower half of the bearing and I the upper half.

These bearings support a shaft made of ½-in. cold rolled steel about 18 in. long. On one end of this shaft, fastened by means of a ¼-in. set screw, is a piece of steel 1 in. square by 2½ in. long marked A in the sketch; this piece holds the upper part of the ½-in. telescope tubing and transmits the motion of the telescope tube to this ½-in. shaft.

The tube is held in this head by means of the slotted end and thumbnut which, when screwed down, holds the tubing rigidly in the head. This provision is needed, as the distance from the center of this shaft (M) to the center of the crosshead pin varies with the different makes of engines and also the different sizes and types of the same make of engines. The different lengths of stroke of the pistons on different engines will also affect the amount of telescoping of these 2 tubes, so they must be adjustable in regard to length to meet these different conditions.

Figures A, C, D, E, F and G illustrate the two steel heads. Two of these are required in the apparatus, one on the rod from the crosshead pin and one on the upper shaft. The two heads are similar, excepting the holes for the telescope tubing, one being drilled for a ½-in. tube and the other one for a ⅝-in. tube.

In this apparatus I use steel telescope tubing 2 ft. 6 in. long, one length of tubing having an outside diameter of ½ in. and the other an inside diameter of ½ in., or a few thousandths of an inch over ½ in., as the tubes are a nice sliding fit over one another.

The lower steel head receives its motion from the crosshead by means of a ½-in. rod, as shown at L, which is screwed into the end of the crosshead pin. This head has a set screw on its side near the end, which engages in the slot of this rod (L); this holds the head onto the rod and still permits the head to rotate slightly on this

rod, which is caused by the reciprocating motion of the crosshead pin.

I generally carry about five different lengths of the pin, L. The following lengths I have found to be the ones most often used: 2½, 3, 4, 5 and 6 in.

Nearly all crosshead pins of medium sized engines up to 250 hp. are drilled and tapped in the center of either end for a ½-in. (12-thread) eyebolt; so these pins can be safely made ½ in. diameter and threaded on one end far enough to insure a good grip in the crosshead pin and allow for one or two jamb nuts to keep the rod from backing out when the engine is running.

On the upper shaft is a piece of red fiber made up as shown in sketches P and Q. This is the medium through which the indicator receives the reduced motion of the crosshead by means of a cord which passes over the radius of this piece in a 1/16-in. groove.

I have six different sizes of this part of the apparatus for different lengths of stroke of the engines. The sizes are with 2½, 3, 3½, 4, 4½ and 5-in. radii.

These pieces can be used in a vertical position, as illustrated in the side and end views of the assembled apparatus, or the upper or grooved part can be placed down or opposite to the present position in the assembled drawing. It must, however, be borne in mind that this change will convert the crosshead motion from indirect to direct; that is, in relation to the indicator.

In setting up this indicator, always see that the cord running to the reducing apparatus is parallel with the piston rod of the engine both ways; otherwise you will have a distorted indicator card.

In using this apparatus, be sure to keep every moving part and joint well oiled, especially the telescope tubes.

Effect of Ash on Efficiency

AS SHOWING how increased impurities in coal affect conditions, some figures given by the Fuel Engineering Co. are of interest. With a coal having in 1916, 9.88 per cent ash, 4.8 per cent moisture and heat value of 13,362 B.t.u. per lb. as fired, evaporation of 8.58 lb. of water per pound of coal was secured. Allowing 1192 heat units as an average for the total heat of the steam, which is correct for 125 lb. pressure and inaccurate by only ½ of 1 per cent for pressure from 87 to 192 lb., the heat added to a pound of water to make a pound of steam is found by adding 32 to 1192, giving 1224 and subtracting from that the temperature of feed water in deg. F.

For good conditions, this temperature may be 210 deg.; and 1224 — 210 = 1014 B.t.u. added to make each pound of steam. For 8.58 lb., the heat added will be 8.58 × 1014 = 8700 B.t.u.; and 8700 ÷ 13,362 ÷ 0.6511 or 65.11 per cent efficiency.

In 1917, the coal showed 15.23 per cent ash, 5.1 per cent moisture, 12,360 B.t.u. per pound as fired, and an evaporation of 7.2 lb. water per pound of coal.

For the same operating conditions, 7.2 × 1014 = 7300.8 B.t.u. added, and 7300 ÷ 12,360 = 0.5907, or 59.07 per cent efficiency.

It is estimated that each 1 per cent increase in ash decreases the possible efficiency of the furnace 1.5 per cent. As the increase in ash for 1917 over 1916 was 15.23 — 9.88 = 5.35, the decrease of possible efficiency was 5.35 × 1.5 = 8.02. This subtracted from 65.11 = 57.09 which would be the probable efficiency for 1916 with the coal as supplied in 1917. The actual efficiency of 59.07 shows that the boilers were better handled in 1917 than in 1916, and that the low evaporation per pound of coal was due to the greater amount of ash and moisture in the coal. Or looking at it the other way, if the coal in 1917 had been as good as that in 1916, the efficiency would have shown up 59.07 + 8.02 = 67.09 per cent, as against 65.11 obtained in 1916.

No Exemption

By Strickland Gillilan

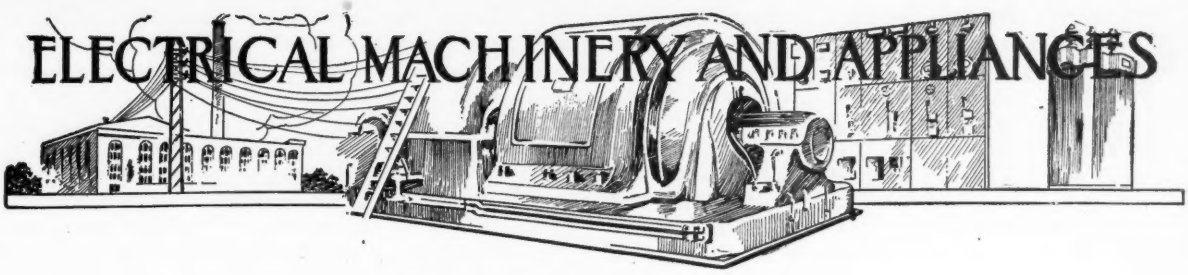
Author of "Off Ag'in, On Ag'in, Gone Ag'in Finnigin."

IF you cannot launch a bullet at the fiend across the sea,
Buy a bond!
It will reach its little target straighter than a homing bee—
Buy a bond!
If you've bought a lot before,
Don't believe you've done your chore—
Buy a half a dozen more!
Buy a bond!
'Tisn't often helping others helps yourself, so all-at-once—
Buy a bond!
Help the country, help your bank book—every slacker is a dunce!
Buy a bond!
If your country's saved, all right!
There's your money good and tight.
If it isn't—well, good night!
Buy a bond!

If the bond should prove a flivver, all the money that you save
(Buy a bond!)
Isn't worth a single penny—what is money to a slave?
Buy a bond!
It will keep the kaiser's hordes
Back, as well as two-edged swords!
If your pocketbook affords,
Buy a bond!

If you are a common tightwad, loving no one but yourself,
Buy a bond!
It's the surest and the sanest way to save your measly pelf—
Buy a bond!
If you are a decent critter,
'Gainst the foe of freedom bitter,
God Almighty hates a quitter—
Buy a bond!

WHO IS NOT for his country in this time of need must be against her. Action is the sole proof of patriotism; there is no such thing as patriotic inertia. Only those who do something, say something, give something for their country; and who do nothing, say nothing, give nothing in aid or comfort of the enemy, are Americans today.—C. H. MACKINTOSH.



Electric Motors---I

TYPES OF MACHINES AND THEIR CONSTRUCTION AND CHARACTERISTICS. BY GORDON FOX

THIS article is intended to discuss present-day commercial types of electric motors and to bring out their desirable features as a guide in the selection of machines from the standpoint of mechanical design and construction.

Electric motors are called upon to drive a wide variety of machines and to fulfil a diversity of demands. It is impossible to build a single line of motors which will meet the needs of the many different fields of application. The service demands are classified, however,

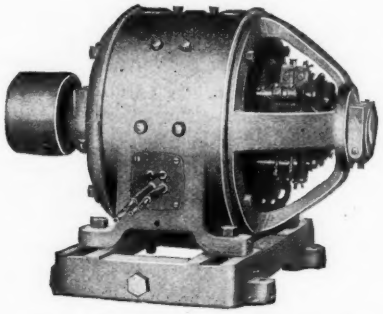


FIG. 1. A GENERAL UTILITY DIRECT-CURRENT MOTOR

and a few lines of motors built, one of which will be suitable for any ordinary application. In addition to the general lines machines are also available for special cases. There is, also, a pronounced tendency toward the adaptation of standard motors, or, at least, standard working parts, for individual application to driven machines through the use of special frames, mountings or mechanical features.

Standard direct-current motors are available in four general classes, namely: Commercial general utility motors; enclosed box frame or crane and hoist motors; railway motors; and mill type motors.

The commercial general utility motor is the prevailing type. It is standard with shunt or compound windings, 20 to 40 per cent compound being afforded. Constant speed motors of this type are normally rated on a continuous duty basis. Adjustable speed motors are rated both for continuous and for intermittent duty. These motors are of open construction, although semi-enclosing and totally enclosing covers may be added, the latter type reducing the heat dissipating ability and lowering the horsepower rating of the machine. Being widely used, motors of this class are sold under keen competition and their design and construction represents a compromise between sturdiness and cost.

The frame of the open type motor comprises essentially the magnetic yoke, the bearing brackets and the supporting feet. The yoke is of ring form, because this design has been found most economical in material and may be of cast iron, cast steel, rolled steel or laminated iron. Cast iron has comparatively low magnetic permeability so that a large cross section is required. Cast steel is commonly used. One prominent commercial design makes use of a rolled steel ring arc welded at the joint. The main advantage of a rolled over a cast yoke lies in the certainty of a uniform magnetic circuit. Castings sometimes have blow holes which lead to uneven flux distribution, affecting performance. In the larger motors it is desirable to have the frame split horizontally so as to afford access to the armature.

Box frame or crane and hoist motors are designed for service quite different from that of the general utility type. This motor is not a continuous duty machine. It is used almost entirely for crane and hoist service and for the many applications requiring great turning effort for short periods, the motor being commonly under the control of an operator while running. Motors of this type are commonly series wound to afford maximum starting power and to require the minimum

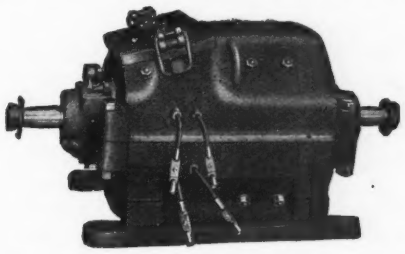


FIG. 2. DIRECT-CURRENT ENCLOSED BOX FRAME OR CRANE AND HOIST MOTOR

number of collector bars when used on moving parts such as cranes. Motors with about 10 per cent compounding are furnished, however, to restrict the light load speed when this is desirable. These motors reach excessive speeds when operated without load and must always be geared, coupled or chain connected so that the load cannot be entirely removed. The service being irregular, these motors are rated on an intermittent duty required.

Box type motors are completely or largely enclosed because they are commonly located in dirty or damp places or exposed to the weather. They are somewhat more rugged than general utility motors because the high torque duty and irregular service impose greater stresses upon them. The frame is usually of cast steel, of box or barrel shape, with four supporting feet. The frame should be split horizontally to permit access to and removal of the armature in places of difficult access such as cranes. Back axle or countershaft brackets are often supplied, being bolted to planed pads on the side of the frame. Pads are also provided on the ends of the frame for mounting a brake and the shafts are made with double extensions for this purpose. Like general utility motors, these motors may be arranged for side or inverted mounting and, in special cases, they may be mounted vertically.

Railway type motors are designed especially for railway and traction service and are now little used for other applications. They are of enclosed design, due to their location under cars. Recent designs, however, are partially open, providing air circulation through the armature spider. Space limitations necessitate compact design. Frequent starting and acceleration demand series windings. Irregular duty dictates intermittent ratings. The high voltages used in railway work makes

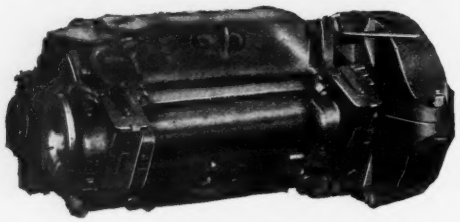


FIG. 3. DIRECT-CURRENT RAILWAY MOTOR

necessary good commutating features and good insulation. The feature of portability requires elimination of excess weight.

Mill type motors are built primarily for service in steel mills and allied industries. They are used in these plants both for auxiliary drives on the mill machinery and for cranes, hoists, ore bridges and similar applications. They are designed particularly for rapid acceleration, quick stopping and frequent reversal of heavy loads, such service being typical with the manipulating drives in the mills. They are always under continuous manual or automatic control and require intermittent service ratings. They are built standard with series or compound windings, the series field predominating in the compound motor. They are ordinarily totally enclosed because of their use in dirty and exposed locations. The frame is of cast steel, cylindrical in shape. In general dimensions they are longer and narrower than ordinary motors, the armature being long and of small diameter to aid quick acceleration and reversal. The frames are split horizontally to permit ready access to and removal of armatures, field poles and bearings. The upper frame casting is hinged on one side. The field connections on the other side are made outside the frame so that they may be readily disconnected prior to opening the frame. Every provision is made for quick repair or exchange of parts primarily because of the seriousness of delays in mill applications and also because of use on cranes and in places difficult of access.

Mill motors are standard both with and without countershaft brackets, which, when supplied, form a part of the lower frame casting. Shaft extensions are provided at both ends of the motor for pinion, coupling or brake, when such is used. Tapered shaft extensions are provided to insure easy removal of pinions, together with a tight, true fit. Mill motors are provided with four wide spread feet which should afford sufficient room for both holding down bolts and dowel pins. The feet are preferably symmetrically located with reference to the shaft extensions, so that the motor may be turned end for end if desired. This permits locating the terminal leads to best advantage and also offers a means of quick repair should pinion or coupling give trouble. Bracket motors are not reversible in this sense.

Pole Pieces and Armatures

The pole pieces of direct-current motors may be of steel or laminated construction. Laminated poles are preferable, as they permit higher flux densities and also reduce eddy current losses which occur in the pole faces due to flux pulsations incidental to armatures with wide slots, particularly with small air gaps.

Laminated poles are definitely uniform as against uncertain cast poles; they also permit greater accuracy in manufacture. The laminations in the pole pieces need not be as thin as those of the armature stacking, as the magnetism in the field poles does not reverse as does the armature flux. In some motors, notably those for elevator service, a short-circuited damping winding is introduced in the field pole faces. This causes the field circuit to build up, or change values more slowly and insures more gradual acceleration and smoother speed changes.

Pole pieces should be bolted to the yoke, not cast in. With the latter construction there is always uncertainty as to the joint between pole piece and yoke. Through the use of drilling jigs, bolted-in pole pieces may be spaced with great accuracy, whereas it is impossible for the molder to locate the pole pieces in the sand with similar precision. A great advantage of bolted in pole pieces lies in the ability to remove individual poles and coils for repairs without removing the armature. Bolted in pole pieces also have an advantage in flexibility, as they permit adjustment of the air gap by means of shims.

Interpole pieces are generally of solid steel but laminated construction is sometimes preferable, especially in the case of fluctuating loads.

The armature of a direct-current motor is best made up by pressing onto the shaft a cast spider upon which is mounted both the armature stacking and the commutator bushing. With this construction it is possible to press the shaft in or out without disturbing the windings. In the smaller sizes this construction may be supplanted by one in which the laminations are held firm by end rings, the commutator bushing being attached to one end ring to make stacking and commutator a unit. With this construction it is also possible to remove the shaft, leaving the working parts intact. The sacking is made up of soft iron laminations varnished to reduce eddy currents. Open slots are used in all but the smallest motors because this permits the

use of form wound, insulated and treated coils. It is well for the last few laminations on each end of the stacking to be of heavier stock than the rest, to prevent vibration. Fingers for buttressing the teeth should be attached to the end laminations. Ventilating ducts, if used, should be liberal to prevent clogging. If bands are used outside the stacking they should be recessed so as not to decrease the mechanical air gap and to prevent injury to such bands while inserting or removing the armature. Cast-iron end plates, secured by ring keys, holding the stacking together, may well be designed to serve also as supports for the end connections. Oil thrower discs are sometimes pressed onto the shaft outside the spider to prevent creepage onto commutator and windings.

The Commutator

This is a delicate device but a high degree of perfection has been attained in its manufacture. The segments should be of rolled or drawn copper, not cast. The mica segments should be of soft amber mica, finely split and cemented with a binder which will not disintegrate and pit. The segments should be of uniform thickness. Recent tendency is toward undercutting the mica in all cases where collection of dirt in the slots is not probable. This is done not only to prevent "high mica" troubles, but also to enable the use of brushes best suited in all features except that of mica abrasion. Undercut mica is particularly desirable in machines having many narrow commutator bars, where the mica represents a fair percentage of the total surface.

The mica V-rings should be made in one piece to lessen liability of grounds at the corner. Insulation should be provided between the bore of the commutator and the bushing. It is well for the mica segments to extend beyond the copper at the inner end of the commutator to prevent leakage across bars at this point where dirt is likely to collect. The risers may be solid, the ends of the bars being slotted for the armature connecting leads or open risers may be used. Open risers afford advantage in ventilation and involve less likelihood of breakage of the leads at the point of connection. Solder throwing seldom occurs with open risers. Solid risers are commonly used for small armatures because cheaper to construct. Railway and mill type motors usually have solid risers to secure liberal commutator dimensions in connection with a narrow diameter armature.

Windings

The armature windings of all but the smallest direct-current motors are assembled from coils formed and insulated before insertion. The span of the armature coils may be equal to or slightly more or less than the pole pitch. The latter type is termed a chorded winding and is used extensively in non-interpole machines, having the advantage that both sides of the coil are not in the neutral zone at the instant of commutation. The short-circuited coils may thus have corrective voltage generated in them to aid reversal of the current. Diamond coils, with modifications, are quite universally used in direct-current motors. Wave windings are employed ordinarily in all but the largest motors because this type of winding permits the use of less turns and larger size conductors. Coils may be made up of round wire, rectangular wire or strap copper. Rectangular wire has advantages over round wire in that less space is used for insulation, the coils hold shape better and the pressure is distributed. The thrust of the conductors in an armature is considerably more than is appreciated. Square wire has the advantage over odd rectanglar shapes in that it is semi-standard and may be obtained readily for repairs. Double cotton covering is used for most armature conductors, the coil being taped and treated with varnishes. The coils of railway and mill type motors are generally insulated with built-up mica next to the coil, a cotton tape being used on the outside to hold the mica in position. This is good construction, as the insulation next to the conductor is materially hotter than that next to the slot. The use of mica or asbestos insulation permits operation of the motors at higher temperatures and is particularly applicable to machines of the enclosed types. Armatures are ordinarily connected with a throw of half a pole span so that the brushes must be located opposite the center line of the poles. Some armatures are connected straight out, however, bringing the brushes opposite the interpolar position. Either bands or wedges may be used to retain the coils in the slots, although wedges are

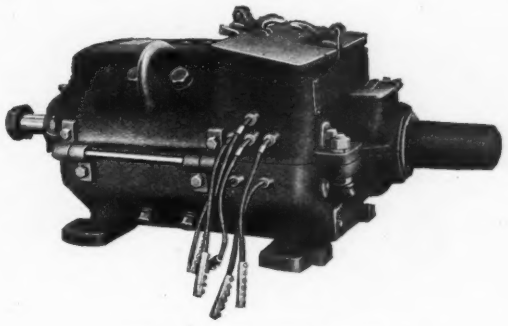


FIG. 4. MILL TYPE MOTOR

preferable, as they allow more ready access to individual coils for repairs. They also remove one source of grounds and short circuits, bands not infrequently cutting through the insulation and leading to trouble. Bands are universally used for retaining the end connections. No little thrust occurs in the end connections due to stray magnetism and they should be securely banded onto a supporting shelf to avoid movement and consequent chafing. Freedom and exposure for ventilation should be afforded so far as possible, however. In the larger machines, made-up bands are commonly used which are simply clamped together, permitting easy removal and replacement.

Field coils of a motor are subjected to mechanical shock and vibration, magnetic thrust, repulsion and attraction between turns and expansion and contraction due to heating. They must therefore be tightly wound and securely fixed against all movement. They may be subjected, not only to the normal impressed voltage, but to the high induced voltage or kick which occurs if the field circuit be opened suddenly. They must therefore be well insulated between terminals and between layers as well as from the pole pieces and frame. Shunt coils are in circuit quite continuously so that heat dissipation requires attention. Space economy is a desirable fea-

ture, but undue crowding is to be distinctly avoided. Shunt coils for small machines are commonly wire wound under tension, cotton or enamel insulation being used. Rectangular wire is used for the larger machines, giving a better space factor and more rigid construction. The layers may well be insulated from each other by paper strips. The end turns are retained by strips of tape or paper encircling them and in turn held under the central portions. The portions next to the pole pieces are insulated with press board, reinforced at the corners. The coils are frequently taped over all and treated, but, where construction permits, it is better to omit most of the outer taping to expose the surface of the coil more effectively for radiation. Field coils, more especially in the larger sizes, may be sectionalized, ventilating spaces being introduced between sections. The coil ends should be anchored within the coil and attached to flexible leads brought out for connections. Another good construction provides terminals attached to the anchored coil ends, jumpers being used to connect from coil to coil. Shunt field coils are usually treated by repeated varnish dips and baking, although the vacuum impregnating process is applied in some cases. Special treatments can be applied to motors to be exposed to moisture, chemicals and fumes.

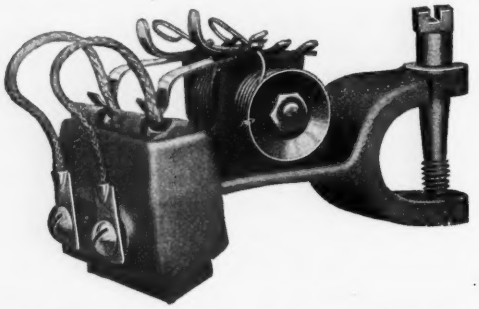


FIG. 5. TYPICAL BOX TYPE OF BRUSHHOLDER

Series and interpole field coils of the larger machines are commonly constructed of strap copper wound on edge, insulated only by strips of paper or asbestos between turns and clamped in a pressboard spool. This is a solid and compact construction and an excellent one from the viewpoint of heat dissipation. In the smaller machines wire wound coils, usually of square wire or flat strap, are used, the construction being similar to shunt coils. In some machines the interpole winding is concentrated in a short coil near the pole tip, instead of being distributed evenly along the entire pole piece. This is done in order to minimize magnetic leakage.

In some of the smaller compound wound motors both the series and shunt turns are made up in a single coil. This practice is not to be commended, inasmuch as it introduces greater possibilities for electrical breakdown and renders repairs more difficult.

Brushholders and Brushes

The box type of brushholder is now used almost universally for motors, although rocker-type and reaction type holders are occasional. Reaction type holders require specially shaped brushes. They are particularly good where very quiet operation is desired, as for elevator service in office buildings. The fit between box and brush with a box type holder must be snug to prevent rocking of the brush. Long boxes hold the brush steadier than short boxes. The springs should be designed to follow up wear without change in tension, and provision for adjusting the tension should be made. Both brushholders and tension springs should be protected against corrosion. Brass holders are preferable to iron in this feature and bronze springs are better than steel. The brushes should be provided with shunts to avoid trouble at the sliding contact and to prevent current from heating the tension spring.

There should preferably be two or more brushes per stud and always more than two brushes per machine. Long studs should be braced at the outer end to secure rigidity and prevent chattering. The brushholders should be insulated from the frame through the use of porcelain, bakelite or similar material. Fiber has the bad property of expanding and contracting with moisture, ultimately loosening the joints. Provision should be made for shifting the brushes, preferably without disturbing the machine in operation. The brushes of interpole machines should be dowelled, but chance for adjustment is desirable in case exchange of armatures or other cause makes some shifting necessary. Brushholders should be staggered to secure even wear and prevent grooving of the commutator.

The brushes in a motor must be suited to their work. The subject of brushes is too broad to be covered in a general article, demanding the consideration of many details.

Bearings

The first requirement in bearings is liberal size. The bearings of small motors are usually held by end flanges attached to the yoke. The alinement being accurate, fixed sleeve bearings are permissible. All pedestal type bearings should be self-alining, and preferably split. The bearings of most small motors are of the solid sleeve type. It is desirable, though not common, for the rear end flange to be split and equipped with a split bearing. This construction permits easy removal of the armature without removing pinion or coupling. In the larger motors of the self-contained type, split flanges and bearings for both ends are desirable. It is well for the bearings on both ends of the motor to be in duplicate, thus reducing the spare parts item. Oil wells should be liberal to reduce attention and minimize troubles. Oil gages and effective means to prevent overfilling are important. Two oil rings per bearing introduce insurance against troubles due to a stuck ring. The end of the bearing housing should be closed by a cap to prevent entrance of dirt. Effective means, such as wiping washers, for prevention of oil leakage along the shaft into the machine, should be provided.

The solid sleeve bearings of small motors are usually of bronze, made in one piece. The larger split bearings are generally of the babbited type, a cast-iron outer shell being used. Bronze is sometimes used for the outer sleeve to prevent injury to the shaft in case the babbit melts and runs out.

Ball bearings have many advantages for use in motors and their more general adoption is to be desired. As the running friction loss of a motor is very low, ball bearings do not greatly improve efficiency. They do,

however, decrease static friction more markedly and make possible more compact designs and save space. They are extremely reliable, require little or no lubrication and almost no attention. The wear is small, making them particularly desirable for induction motors. The wearing parts are separate from the shaft so that it is never necessary to turn down the shaft to an odd size. Ball bearings may be installed either with or without end play. Wherever the drive permits, end play should be afforded.

Frazil Ice Handling Methods

By J. A. Walls

THE OPERATING engineer groups under ice difficulties a number of occurrences, which, however, are quite distinct from each other in their origin, in the provisions that should be made, or are made in the design of plants to guard against them, and in the operating methods employed to mitigate or eliminate their disturbing effect.

There are three distinct causes of ice trouble:

First, primary ice. This may freeze up a shallow lake in a low-head plant, or a small river in a high-head plant, to such an extent that the river flow is reduced or improperly diverted, or that a head race or tail race channel can carry only a portion of the flow that should normally go through the plant;

Second, secondary ice. Following the first thaw the ice from creeks and tributaries is carried down into the main river and a plant may experience one or several occurrences of up-river ice attacks during one season, depending on the magnitude of the first winter or spring flood, and on whether or not succeeding frost periods produce other accumulations and moving of ice from the tributaries;

Third, frazil and anchor ice. Both are formed under similar, although not identical, conditions. However, the effect of each on the operation of a hydro-electric plant is nearly the same, and the methods of diagnosing and guarding against them are identical. They are common occurrence in plants located in northern climates and less usual in modern climates, although equally serious in their interference with plant operation.

Provisions Against Trouble From Primary and Secondary Ice

THE SELECTION of a site, the general layout of a hydro-electric plant, and the design of a head and tail race channel, as well as the location of effective ice skimmers, chutes, diversion gates, etc., should be arranged to take care of the operating difficulties from primary and secondary ice. The variety of these provisions is great as to design and effectiveness for different plants and climates.

At the Holtwood plant, on the Susquehanna River, 25 mi. from its mouth, quite effective protection against primary and secondary ice has been gained by placing the intakes in a cove and in such a relation to the river bends that the river currents act to throw the floating ice masses to the opposite side of the river. Other structural provisions which were made to take care of the outside ice that may enter the forebay or the gate house have been provided, but never called into use. One would feel inclined, from this experience, to suggest a closer attention to existing natural ice protection when selecting a site or determining the layout of new plants, than has been given in many instances in the past, to avoid the predicament of some plants that have an almost annual shut-down due to choking up of intakes with up-river ice.

Guarding Against Trouble From Frazil and Anchor Ice

A HYDRO-ELECTRIC plant may be perfectly protected against the first two ice troubles mentioned and prove helpless against attacks of frazil and anchor ice; although against this kind of ice trouble, particularly in northern climates, conditions may be ameliorated by a favorable location of power house site.

However, assuming that the formation of frazil or anchor ice has not been prevented, and that such ice enters the power house intakes, the method of reducing or eliminating service troubles therefrom, requires two steps; one aiming at an early diagnosis of a probable or imminent ice attack, the other comprising all action taken to put the plant equipment and the whole operating system in the best shape to meet the attack, and also to free the plant of ice that has actually formed on important parts of the equipment, notwithstanding all precautions.

Diagnosis

THE QUESTION appears somewhat obvious—Why lay so much stress on the diagnosis of something that gives an unmistakable sign of its presence without being searched for? Only an operating engineer who has witnessed a severe run of frazil ice, can appreciate the rapidity with which a seemingly harmless forming of white fringes around rack bars and in-takes increases, to the complete checking up of several thousand square feet of flow cross-section.

When frazil ice actually passes through the plant there are so many things to be looked after constantly that the half-hour or so that may be gained by a foreknowledge of the incipient stage of ice formation is most valuable for getting everything in readiness, including, of course, the human element. If, in a frazil ice attack, the ice is once allowed to accumulate beyond a certain point, the battle is lost. Early diagnosis is most important.

A thorough understanding of the nature of frazil and anchor ice, and of the atmospheric conditions (differing in various climates) that favor such ice formation and determine the time of onset of ice difficulties, should be disseminated among all members of the operating force.

Frazil ice is formed during cold weather and high winds in the absence of any protective ice coating on the lake. Under such conditions the water becomes superchilled. Ice needles then appear and by sticking to the racks or turbine parts choke off the water from the

turbines or prevent the operation of the turbine gates. Ice thus formed persists in the lake until a rise in temperature of the water (due generally to sunshine) and a decrease in the winds result in melting the needles or allow them to form a surface sheet of ice. Dull and windy days with little prospect of the sun's rays piercing through the cloudy sky aggravate the difficulties. At the Holtwood plant frazil and anchor ice have never formed when the storage pond (reaching about 8 mi. up-stream and bounded at the head by rapids) was covered by a protective ice coating, but they are to be expected at the beginning of the first cold spell in winter, before the protective ice coating on the lake has formed, or during the winter or towards spring after a run of up-river ice or thaw has carried out the lake ice and before a renewed cold spell produces another protective coating.

Anchor ice is formed when there is no ice covering on the lake, or only a thin sheet of clear ice, on a cold night when the sky is clear. The anchor ice then forms on the bed of the river and is detached therefrom in huge masses of slush-like material when the water temperature is slightly raised, usually a little after sunrise.

Assuming the existence of conditions favoring an on-set of frazil or ground ice, the operators watch for its appearance. The specific means of early detection employed are as follows:

A test chain, immersed in the flowing water of the forebay, is examined every half hour or at more frequent intervals for evidences of ice.

A graphic thermometer with a large scale around the zero point records the temperature of the water. Frazil or anchor ice cannot form until the water reaches freezing temperature.

Frazil ice forms easily on metal exposed to flowing water, particularly on fine screens. One of the auxiliaries at the Holtwood plant is a 50-hp. turbine that receives its water through a 14-in. penstock, protected by a fine-mesh iron screen. This turbine drives a plunger pump through gear reduction. The intake screen invariably becomes choked with ice long before any other apparatus in the power house shows signs of ice. The turbine-driven pump at first slows down and sometimes comes to a sudden stop. Sometimes a rumbling noise in the turbine casing accompanies the decrease in speed. Whenever atmospheric and other conditions look favorable for ice formation this turbine driven pump is operated continuously at a fixed valve opening, and as it is placed in the pump tunnel within hearing distance of an operating attendant, it serves, through the variation of the gear noise with the speed, as an acoustic signal for the indication of imminent ice trouble.

Protective Features and Operating Precautions

Naturally, a plant can be protected more effectively from operating difficulties due to ice when this object has been kept in view from the start. Some of these protective features to be considered in the original design of a plant are as follows:

Enclosure of gate house and provision for heating it, such as letting the warm air of the generator room enter it or in high-head plants by heating it artificially. In case this is done by electric heaters the amount of energy required is relatively small if proper provision is made for circulating always the same air and directing it into the head gate channels and above the screens, where the warming of half submerged metal parts is most effective.

Depending on the number of screens, correspondingly quick means of removing them on short notice should be provided; quick lowering of head gates should be insured under all conditions.

Frazil ice chokes up at first the small spaced openings of screens and then the guide vanes or runners of the smaller water wheels. None of the important auxiliaries, therefore, should depend solely on water-wheel drive. This refers to the small water wheels that are used for driving exciters, governor or hand-control pumps, and other station service apparatus. Sufficient spare capacity must be provided by alternating-current driven exciters or under severe conditions even by separate steam or gasoline prime movers, always to insure station light and power for the operation of cranes, lubricating pumps, governor auxiliaries, air compressors, etc.

An emergency storage battery is highly desirable to tide over any temporary trouble with the alternating-current or turbine-driven exciters.

That type of turbine installation exposing metal surfaces to the warm air on one side and to the ice-bearing water on the other side, is better suited to withstand a long ice run without appreciable reduction of capacity, than the type of turbine installation where the turbine parts are pretty thoroughly heat insulated from the warmer portions of the power house, i.e., where, for instance, the turbine parts are set in concrete pits and have only a small heat conduction cross-section connecting the submerged turbine parts to the warm air of the power house. In any event, conditions can be still further improved if hot air taken either at the top of the generator room, or artificially produced, is directed by a blower, or by a natural ventilation as close as possible to the water exposed parts of the turbine installation.

Notwithstanding all precautions, it may be possible that a water wheel is rendered inoperative by the accumulation of ice in the runners, in guide vanes, or around the operating mechanism, which may be rendered immovable by the freezing of a solid mass of ice around it. In the natural course it would probably be many hours or several days before such a disabled unit could free itself from ice, and only the introduction of outside heat would bring it back to service in a reasonably short time. It would be bad practice to permit a unit to freeze to such an extent that its output is reduced to almost nothing, aside from the great danger of a "runaway" if it should get beyond control. The thawing out of the ice will take a disproportionately longer time than the possible benefit obtained in this case by the continued hanging on of the unit to the load at a gradually reducing output. It is much easier to restore to service a unit that has suffered only a moderate accumulation of ice and that can be freed comparatively quickly by the application of steam. Depending on the climate and on the nature of the turbine installation, more or less extensive provision should be made for admitting heat,

preferably in the form of steam, to the interior of the turbines. If such provisions are made from the beginning little valuable time is lost in the getting up of steam and admitting it to the turbine pits in advance of the actual ice trouble during the early morning hours when the load, in most plants, is below the station capacity. The switching over of steam from one unit to another can be done quickly during the actual ice run.

It would be interesting to determine the benefit derived from providing heat by steam jackets around guide vanes and above runners and other vital points.

—N. E. L. A. Bulletin.

Power Plant Docks

Protection of Water Front and Provision for Docking Coal Barges. By R. von Fabrice

THE ideal site for a power plant, other than at a mine, is a place where fuel may be received both by rail and water. Water front location is necessary not only for fuel transportation but also for adequate supply of water for condensing purposes, as a proper supply of condensing water may mean a consequent saving in fuel consumption of 10 to 15 per cent due to the inferior vacuum and additional steam required to furnish the power for the additional auxiliaries required with a cooling tower installation. The quantity of water required for condensing purposes is dependent upon the initial temperature of the water as well as the type of condensers used and varies from 500 to 750 lb. or approximately 8 to 12 cu. ft. of water per kilowatt-hour of station generator capacity.

Water levels are of prime importance in the design of a steam power plant. Floods, perigee tides, as well as mean high and low tides, should be thoroughly investigated before proceeding with either the design of the station or the purchase of condensing equipment for the power plant.

Docking facilities and water rights, ample supply of usable water for condensers and boilers are of the utmost vital importance for a successful steam power plant, and therefore the selection of the station site should be most carefully analyzed. Space for coal storage and facilities for handling it, for both present and future demands, including space available for 60 to 90 days' supply of coal, depending upon the location of the station, should be provided.

The cost of the land and the geological formation, railroad facilities as well as the ultimate transmission and distribution systems should be given the most careful consideration when selecting the site.

The construction and treatment of the water fronts to provide for proper protection and docking facilities lends itself to innumerable modifications and in the design of docks for the average power plant the following conditions must be fulfilled:

1. Sufficient length for the vessels to be unloaded.
2. Dredging for sufficient depth to provide safety to float loaded vessels at low water.
3. Non-interference with present and future harbor improvements.
4. Compliance, on navigable streams, with War Department rulings.
5. Proper sea walls, breakwaters, etc., for the protection of vessels as well as docks.

The details of the dock are governed by:

1. Depth of water required.
2. Property available.
3. Shape of property.
4. Coal handling facilities.
5. Water conditions.

The primary stresses developed in a dock are due to:

1. Resistance of dock to withhold back fill, thus developing stresses in the dock as a retaining wall.
2. Live load on dock due to coal handling machinery, etc.
3. Stresses due to anchorage and bumping of vessels.
4. Corrosive and deteriorating action of elements as well as the infection in the water.
5. When a dock is back-filled it must resist all retaining wall stresses in addition to the surcharge stresses due to coal handling equipment and material stored.

The docking stresses imposed by the vessels are due to mooring of boats as well as destructive blows delivered by the boat striking when docking.

Deterioration of the structure is due to the elements, erosive action of water and tide or current, floods, climatic and atmospheric conditions, as well as alternate drying and wetting of the structure, sewerage and chemical action; ice floes or jams also do their part towards the rapid destruction of a dock.

Docks for the average power plant are usually back filled and are subjected to the pressure of the fill and must withstand retaining wall stresses. Their design is governed primarily by the ground and water conditions.

The above conditions determine the design of the structure while the materials of construction selected are influenced by chemicals and sewerage in the water, teredo or marine growth, while the ground conditions or geological formation and depth of water determine the height details of the foundations, superstructure and anchorages.

Docks subjected to wave action must be designed to resist the impinging waters or waves, which in turn are governed by the depth of water, exposure of dock to wind and storm and profile of ground or bottom. Careful studies should be made of all the existing conditions in order that the proper type of construction as to foundations, superstructure and protections are provided to meet all the specified demands of the individual case.

Dock failures are chiefly due to faulty selection of materials, poor construction details, improper distribution of superimposed loads, poor foundations and improperly designed anchorages.

The accompanying sketch shows details for a type of dock which has proved to be very satisfactory for fronts having water varying from 15 to 25 ft. in depth.

The construction consists of two rows of closely driven piles 18 ft. apart, which are tied together at the top with 8 by 16-in. timbers bolted lengthwise to the

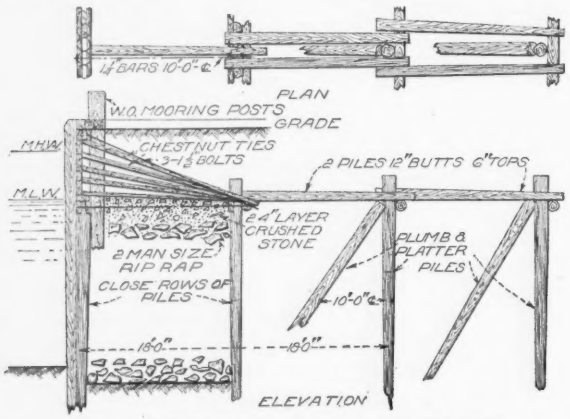
butts of the piles and tied together with 1¼-in. round rods passing through the stringers back to the plumb and batter piles. The entire structure is held back by the two rows of plumb and batter piles spaced 18 ft. apart in bents of 10-ft. centers. Backing logs are bolted to the tops of the plumb and batter piles and a set of two 12-in. butt and 6-in. tip piles are spiked to the backing logs, thus completing the back tie.

The timber face, or portion above mean low water is constructed of 8-in. timbers spiked together and anchored back on 10-ft. centers to the rear row of close piles with chestnut ties which are dovetailed into the facing timbers. The top of the face is finished off with a 12 by 12-in. timber forming a bumper. Long leaf yellow pine lumber gives the best results for the face construction.

Mooring posts should be spaced on about 50 ft. centers and consist of 18-in. white oak butts held in place with 1¼-in. round bolts anchored to the rear construction, arranged to transmit all stresses to the rear anchors and eliminate direct pull to the face.

The face of the dock should be protected from abrasion due to moorings, etc., by means of white oak fender piles spaced 10-ft. centers.

The method of procedure in building this type of dock is as follows:



PLAN AND ELEVATION OF POWER PLANT DOCK

The two rows of close piles are driven to line, then the two rows of plumb and batter piles. Then the 8 by 16-in. ties are placed on the close row piles; tie piles and tie rods to the plumb and batter piles are then installed. After the ties have been placed, the space between the two rows of closely driven piles is excavated to hard bottom, and at least 2 ft. below desired depth of water on face of dock. The rear row of piles confining the mud, leaving the space dredged to be filled in with two-man size riprap which is brought up to within 2 ft. of the tops of the piles which are cut off at mean low water. Then a layer of 2 ft. of crushed stone is placed over the entire area of riprap and the face structure is then built. The back fill is then placed and held in place by crushed stone.

For more permanent structures the timber facing can be replaced by a concrete retaining wall placed on top of the crushed stone or beginning at the mean low water line.

This type of dock is entirely stable and does not depend upon the batter piles for its stability when completed.

Belt Practice*

COMMON SENSE IN CARE OF BELTS; FORMULA FOR FABRIC BELTS. BY W. F. SCHAPHORST

F. W. TAYLOR was the "great efficiency engineer," and I have much respect for his memory and for the good things he did. He virtually substituted life for death in some industries; and his activities extended into the power transmission field also, particularly the belting field. My ideas along the belting line, though, do not exactly jibe with those of F. W. Taylor. Here is one sentence, for instance, to which I take exception: "In tightening belts, belt clamps with spring balances between them for weighing the tension should be used."

Just because he made that statement, we now have a variety of devices on the market for "measuring tension," some of which, it is claimed, do the work in a great hurry. Many of them are bought and used once or twice, after which they may as well be classed as "junk," because efficiency enthusiasm passes away gradually, after doubt enters the mind as to the logic of the method employed. Scientific management is O. K., but it must be the right kind of scientific management. I do not believe in high belt tension, for it is gradually being learned that tight belts are not essential to positive and efficient belt transmission. The most important points to be observed in the care of belts is to keep them from getting hard, dry and stiff.

The belt scale is not a solution for the belting problem. It is merely a solution for making belts tight. It was Taylor's theory that belts must always run at a certain tension in order that they shall not slip. His theory was based upon another theory which, in turn, was based upon tests of belts that were apparently dry and perhaps hard and stiff. More recently we had another example of tests performed on belts by "theoretical" rather than practical men, and, as a result, they drew conclusions that do not suit waterproofed belts. It is my conviction that belts should be waterproofed. A waterproofed belt does not stretch and tighten with variations in humidity.

Cases are on record where belts were taken up "as per belt scale" on a day when the atmosphere was exceptionally humid. They were, therefore, in a stretched condition. The next day was dry and the natural tendency of belts was to shorten. Shafts, however, are almost immovable and the resulting high tension created hot bearings. Quoting an engineer, "When I started up after tightening the belts, the fun began. Bearings went hot right and left. The manager turned water on the bearings. Boxes on the main driving shaft melted out. One 10-in. belt broke; others ran off. The manager (who instructed the engineer to take up the belts in the first place) came running, yelling at the top of his voice to stop the engine. The owner 'fired' the manager, and it took 3½ days' work rebabbiting the boxes and letting out and splicing the belts before the plant could be run again." That, in a nutshell, explains what sometimes happens when Taylor's method is applied too religiously.

There is another kind of scientific belt management that appeals to me as being better than Taylor's. I call this method common sense scientific management, because it has been my experience that a belt man of good

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judgment doesn't need a belt scale to determine whether or not a belt is running as it should.

The principal thing desired in a belt is to "transmit power without slip." Experienced belt men know that this can usually be done without running the belts tight. As I have already said, pliability is the thing to seek in belts, for the more pliable the belt the greater the coefficient of friction. Soft India rubber, for instance, has a very high coefficient of friction. Why? Because it is so pliable. Have you ever noticed that rubber hardens with age, and as it hardens it loses its so-called "stickiness"? That is really nothing more or less than a reduction in the coefficient of friction.

The same is true of leather, cotton, hair or any other kind of fibrous belt. As long as belts are pliable they don't need tightening. I am not claiming that belts should always be run real slack. It is often impossible. Much depends upon the distance between the shaft center, character of drive, speed, size of pulleys and character of driven machinery. Under no circumstances, though, is it good practice to run belts extremely tight. The greater the distance between shafts the greater the ease with which slackness may be maintained, yet I know of short belts that are quite slack, one belt in particular that is 5 ft. between centers, pulleys 12 and 15 in. in diameter, the speed of the belt high, and the slack side almost touches the tight side.

One of the greatest blessings of the slack belt is the fact that it seldom has to be "taken up." Most of the time spent in caring for "Taylor system belts" is consumed in tinkering with the belt scale, cutting out slices "every so often," and then replacing. But with slack belts it is seldom necessary to take out a slice. The rule with slack belts is, "the slacker the better." I know of drives that have run for over 15 yr. without being touched by a knife.

About the best way to prevent tightness is to use a belt that, in the first place, is wide enough. Don't skimp about paying a little more. Use the old rule of thumb, "a single thickness belt 1 in. wide running 800 ft. per minute will transmit 1 hp.," and you will be safe. Then, don't use pulleys that are too small. I prefer larger pulleys, because with them there is much less danger of slip, a narrower and less expensive belt may be used, and the belt speed is higher. A speed as high as 4000 or 5000 ft. per minute is not too high. In some places, the conditions do not permit wide belts, especially on reversing drives. This is one of the hardest belting conditions to meet. In order to keep such a belt from being stressed too highly, it must be made thick. Its being thick is all the more reason why it should be kept in as pliable a condition as possible. Reverse-drive belts should be kept "snug" on the pulleys, but never tight. Keep them pliable.

I know of a case in England where a camel's hair belt was giving much trouble while running tight. It slipped in spite of the tightness. Later the belt was given the care it deserved and is now running slack, without slip, and is pulling a larger load than it did before. In Pennsylvania is another belt that was once run tight by use of an idler pulley. This is a leather belt. After due care the idler was dispensed with, and now the belt runs slack.

So, summing it all up, it is evident that before buying and using a belt scale, the final outcome of the venture should be given some thought. The most economical way is usually the best. The ridiculousness of the "scientific management method" is best illustrated by quoting these words of a mill superintendent who obeyed the "system" to the letter. He said, "we keep a complete record in our files of every belt in use—first cost, length, width, thickness, how fastened, position, horizontal, vertical or slant, crossed or open, kind and power of machine the belt is driving, date put on, date taken off, maintenance cost, tension before tightening, tension after tightening, date retightened, amount taken out, name of workman who repaired the belt, time required to repair, date on which tensions must be measured again, maximum allowable tension, maximum velocity, minimum velocity, where variable, remarks on condition of belt, kind of belt, manufacturer of belt, and an estimate of the probable life of the belt." Contrast this with the "good judgment method," already described, and I think the reader will "get the point" of my arguments.

Fabric Belt Formula

The rules as ordinarily given for fabric belts made up in plies are something like this: "A 4-ply stitched canvas belt is equivalent to a single leather belt; 8-ply is equivalent to a double leather belt, and so forth." Then, after knowing the equivalent we have to hunt up our rules of thumb for leather belts before being able to decide on a width necessary for a given drive.

The writer has hashed over these rules and equivalents and has hit upon a formula that gives a direct answer without mentioning leather at all. The formula applies to most ordinary belts made up in plies such as rubber, stitched canvas, and balata. The formula is:

$$WS \div \left[\frac{2640}{P} + 136\right] = H$$

where W = width of belt in inches;
S = speed of belt in feet per minute;
P = number of plies;
H = horsepower.

For example, what horsepower may be transmitted by a 10-ply balata belt whose width is 6 in. and whose speed is 4000 ft. per min.? Substituting in the formula we get:

$$6 \times 4000 \div \left[\frac{2640}{10} + 136\right] = 60 \text{ hp.}$$

Thrown into other forms for the determination of either W, S, or P, we have:

$$W = \frac{H}{S}\left[\frac{2640}{P} + 136\right]$$

$$S = \frac{H}{W}\left[\frac{2640}{P} + 136\right]$$

$$P = \frac{2640}{\frac{WS}{H} - 136}$$

Locating Gas Engine Troubles

A Practical Account of Difficulties Overcome

INITIAL difficulties experienced with the running of a new installation of internal combustion engines are, generally speaking, more often due to faulty arrangements and to the unsuitability of the engine installed than to any other cause, and even now power users at times come up against experiences of insufficient margin of power being allowed between the working and maximum outputs of the engine, the manufacturer's commercial rating being relied on too much. Troubles have, in many instances, been traced to the directors of the business, who handle the financial side, not sufficiently appreciating the technical side of the power plant, and in the majority of these cases it is found that the advice of the engineering staff has been overruled. Usually, once the initial difficulties have been surmounted, the working of the power plant is quite satisfactory, and it is with installations of suction gas engines that these troubles more often occur.

As it is the starting of new gas engines that has been most productive of initial troubles, which mainly arise from the foregoing causes, an account of one of these experiences may be of interest, as a very simple cause produced a serious delay in setting the engine to work. The plant consisted of a 50-hp. suction gas engine, with its producer supplied by the same manufacturers, and the trouble was finally discovered to be due to the overlooking of details in the connecting up of the engine and producer. The set was for the driving of the machinery in a brick works, and it was installed by a local engineering firm in accordance with the drawings sent by the manufacturer.

Erection of the engine and producer was carried out satisfactorily, and when the time came for commencing to work the plant the producer was started by lighting the fire in the usual way, and good gas was obtained at the trial cocks between the producer and engine cylinder. Also the air receivers supplied with the starting arrangement for the engine were fully charged with compressed air. Upon admitting the air to the cylinder by means of the starting valve, the engine started off at once and commenced firing, but after running a minute or two slowed down and then stopped.

The starting process was then repeated strictly in accordance with the makers' instructions, and good gas was again obtained at the trial cock on the pipe connected to the engine cylinder, but when the engine was restarted it again took up the firing for a minute or two and then stopped. All the various points of the installation were carefully attended to and this performance in starting was repeated several times, as each time it was thought that the trouble had been located and remedied, but finally the local engineers were at the end of their resources, and had to send for the representative of the manufacturers to get them out of the difficulty. The expert arrived and after an unsuccessful attempt at starting the engine, decided to take down the pipe line between the producer and cylinder in order to ascertain if there was any partial obstruction.

The power was then urgently needed, as the old plant had been put out of use, and the writer, who happened to be in the locality, was asked to have a look at the engine. Upon arrival at the site, the pipes were being replaced, no obstruction having been found in them, and it was apparent that the length of piping between the scrubber and cylinder was considerable. After making careful examination of the whole plant, and noting the experiences which had been obtained in the various attempts to get the engine to run properly, it was noticed that no blowoff or vent pipe to the atmosphere had been fitted at the cylinder end of the gas pipe from the scrubber. A 1-in. diameter hole was drilled in this end of the piping and a cock fitted with a pipe leading outside the engine room and the producer leading outside the engine room and the producer was made ready for another start. When gas was obtained at the trial cock between the producer and scrubber the atmospheric pipe leading from the former was shut off and the fan was kept working sufficiently long to clear the air from the scrubber and pipes out through the vent pipe near the cylinder. When good gas was discharged from the trial cock in this position, compressed air was admitted to the cylinder and the engine at once commenced to work satisfactorily and was kept running for the remainder of the day.

Trouble and Its Cause

Apparently the sole cause of the trouble was due to the omission of the vent pipe at the cylinder end of the suction gas piping, so that although a certain amount of gas was present at the trial cock near the cylinder, this became so diluted with the air remaining in the pipes and scrubber that after firing a few times the gas was too poor to support combustion in the cylinder, consequently the engine slowed down and stopped. There is always a considerable volume of air present in the scrubber and pipes when an engine is installed, and it is necessary to blow this through the vent pipe with the fan on the producer until the air is entirely displaced with gas. The engine should not be started until this has been done, and then the cylinder will be able to receive a charge of good gas during each suction stroke of the piston.

Producer Points

When starting the producer of a suction gas plant, care should be taken to impress upon the man working the fan that this must not be stopped until instructions to this effect have been given, and to obviate any risk of the flame passing into the pipes when testing for gas, it is advisable to fit gauze over the end of the trial cocks. The reason for using this gauze is, of course, well known, as it is the principle of the Davy safety lamp, and the flame becomes extinguished when passing through the gauze.

A water gage fitted on the gas pipe near the engine will show the total resistance against which the gas, commencing as air, has to make its way in its passage through the grate, fuel bed, scrubber, and pipes, through which it has to pass from the external atmosphere to the engine cylinder. If the air is obstructed more than usual, the reading of the gage will indicate this obstruc-

tion and the flow of gas into the cylinder will naturally be reduced, which will have the result of making the charge too weak. If the air is throttled by the regulator usually fitted on the engine, there will then be a smaller volume of both gas and air in the cylinder, and the compression will be lower, which will result in the engine giving much less power.

When the gage is fitted, the attendant can see this process happening, but without such indication he can only learn indirectly by the behavior of the engine, therefore its advantage is apparent. It is also advisable to fit a water gage between the producer and scrubber, so that the action of the producer and scrubber can be independently noted, and the resistance through both can be ascertained at any time. By carefully noting the gages, when the whole plant is clean and in known good order, all subsequent gage readings become comparative and certain as a measure of the conditions of operation of the producer.

Another accessory that could with advantage be supplied with all suction gas engines is a tachometer, for registering the speed of the engine, as with the aid of this the gas and air regulators can be adjusted to a nicety and any deviation of one or the other can be instantly detected by the change of speed recorded by the needle of the tachometer; also the final adjustments can be made so that the speed is maintained with the least quantity of gas. When connecting up the water cooling system of engines using pumped circulation, a funnel should always be provided on the outlet pipe from the cylinder, so that the flow of water can be observed by the attendant, and this provision entails but a trifling outlay compared with the great advantage of being certain that the pump is delivering sufficient water. Another point which should receive attention is the capacity of the compressed air receivers supplied with the engine, as in many cases these are much too small, and receivers of considerably larger capacity could be supplied without affecting the price to any appreciable extent; the advantage of an ample supply of compressed air is well known by all users of suction gas engines.—Gas and Oil Power.

Mastering a Diesel Engine

By John Pierce

On page 301, April 1 issue of Power Plant Engineering, C. W. R. asks the question, "Don't Diesel engineers have any trouble?"

O, ye gods and little fishes! I had almost given up hopes of ever having anything else but "trouble"—so don't get too discouraged, C. W. R.—it comes to all Diesel engineers, and sometimes in large, juicy bunches.

In reply to the question as regards the "hunting" governor, I would say "yes," I've met the gentleman, and I've found several things about the "hunting" governor. Primarily, of course, the engine speeds and so, naturally, does the governor. Speeding is caused by too much fuel. If the governor "hunts" on starting the engine only, it will be because too much fuel has been hand-pumped into the atomizer; a few revolutions will remedy this. If, after the engine has run a little while and warmed up somewhat, it continues to "hunt" and you have no load to brag about, you will find you have two things which will cause the same trouble. One is too much oil still being fed by the governor or fuel pump, and the other is that you have too much air. Lower the air, and if this does not stop it, take a piece of paper—half a leaf of Power Plant Engineering is about the right size and weight, though personally I don't mutilate mine, but use other paper of the same weight—and fold it four times; put the resulting wad under the arms on top of fuel pump suction valve stem on all three of them. You will readily see that if you have too much paper your engine will slow down and perhaps stop; don't wait that long, but take them out and thin your wad of paper down one fold and insert them again. You will find that this will stop your "hunting" trouble and prove to you that your fuel suction valve stems haven't the proper clearance. As your load goes near the engine's rating, you can take out this paper until the load drops off. Then, the first time you shut down, remedy the evil by adjusting the clearance of the valve stems named. Be very careful in this, as too much clearance, if your governor is worn somewhat, will make her pull more, but she will "run off" with you on light loads; this is what causes your "hunting," and she is doing her best to accomplish that very thing, only failing because your clearance has, as yet, not quite reached the danger point. Not enough clearance will cause her to pull less; but if your peak is not near the rated capacity of the engine, it is better to have not quite the standard clearance—say ½ turn of adjusting nut less than standard—and stop, not only the "hunting" and racing on light loads, but also do away with any chances of her "running off."

With all respect in the world to the factory and their men, I would say that while they build fine engines, it seems as if they know nothing in the way of operating them, for when I first had one given me as a plaything and a toy, I experienced quite some queer things. After 6 yr. of it, though, I'm beginning to see that these things all have causes, and all have remedies. I wrote the factory at first, stating exactly how she acted, and invariably would get a prompt reply telling me the trouble *might* be "this, that, or the other thing"—to try so and so, and if that didn't work to try "this and that," and if neither helped, to do "thus and thus," and after doing all these things and a few others, to tell them what *I finally did* to fix it. After several letters of this sort, I stopped asking them and went at it on my own hook, determined to run the "gol dingle dang" thing or "bust." This is what caused my gray hairs. I am feeling pretty content at present, for I believe that I have mastered her. I've had her eating from my hand, now, for a year, and she sure is a beautiful performing old lady.

Let me whisper one little word in your ear. First, let me say that 4 yr. ago I wrote an article beginning as follows: "Don't condemn the engine to your boss, your friends or *yourself.*" See? Well, as time went on, I called myself a fool for writing that. I discovered (?) that the condemned old rip was "no good, never was and always will be." *Now,* I want to *repeat* that paragraph again and say *don't* condemn the engine. I've learned that *I* was at fault, and all she needed was the proper things done to her and not a lot of guess work.

For instance, from the first I had a very light colored blue smoke coming from the exhaust. The erecting man said "unburned gas" (on light load); factory chief said "too much case oil"; boss said "leaky valves" (he had a Ford and thought he knew). I said "helen damnation" and a lot of unprintable things. I ground exhaust valves till I had to use corn medicine to take off the lumps caused by sitting on red hot stud bolts while grinding valves. My atomizers would stop up, my cylinder heads would crack, my exhaust valves would warp and some of them would actually melt. The engine wouldn't pull the load; exhaust would smoke badly on heavy load and high air; air wouldn't build up; engine would slow down; exhaust valve stems had a nasty, sticky, gummy stuff come oozing down and would stick; the engine would knock and clatter; exhaust valves would dance a tango on heavy loads; admission valves would open with a groan and close with a fancy hesitating manner similar to a coy maiden approaching her prospective victim. I repeat, "O, ye gods and little fishes!"

And me? Well, I'll tell you, I did everything I could think of and a lot the other fellow thought of, and without rhyme or reason, sense or theory. This, mind you, covering a period of about 4 yr. Of course, I had asked for, and been refused, a lot of things—mostly reamers. I really didn't know whether I needed reamers or not—I only knew I wanted them. Finally, my boss was away a long while and I up and ordered them on my own hook. They came and I put them to work. I reamed exhaust valve seats and ground in new valves, put admission valve seats on the lathe and turned them up and put in new admission valves. Didn't help a bit. Bought high-pressure gage of small type and tested fuel pump; checks leaked somewhat and I *reamed* them, which helped a little. I put on new fuel noses and timed her—no good; advanced noses—no good. I rebored compressor and put in new rings and pistons—helped a little but not enough; took my last reamer and reamed the very bottom out of the fuel valve seat. This seat sets away down in a little old hole and can hardly be seen—not without a lot of trouble. In grinding in fuel needles, always ground till I had a perfect seat on the needles, thinking, or rather not thinking, but what the seat proper was equally good. On reaming, however, I rigged up a way to look into and see the seat; and I found in each of them several long, deep cracks. Well, I reamed and reamed, until the cracks had been cut away, ground in my new needles—and lo! all my troubles were at an end. There she is, rocking along at her rated load right now and doing it right merrily; has been running continuously for 18 weeks yesterday, and has never "cheeped." No dancing exhaust valves, no hesitation on part of admission valves, no oozing ooze on exhaust valve stems, plenty of air, no dirty atomizers, no cracked heads, no blue smoke, and no curse words. She's been a sweet old dear for over 16 mo. now, and I sure am proud of her.

In passing, let me tell of one very peculiar thing. When my atomizers would completely stop up and no fuel was admitted, the heat of compression would, in an hour's time, actually melt the exhaust valve, the seat, and invariably crack the bridge in the head. As long as a little fuel was going in, this would not happen. Why should compression melt the metal and make more heat than the firing of the fuel? Is it possible that heat of compression is actually greater than the heat when firing is taking place? The above-mentioned results would surely prove this to be so, for to prove our point, the manager and I deliberately stopped up one atomizer and after putting in a set of well ground valves started up and ran one hour, watching results. Of course, she only ran on two legs and didn't do a very nice job of it; but in one hour a hole as large as a quarter had been melted in the valve and a corresponding channel equally large in the bridge, and the bridge was cracked. We did this in order to prove to the manager that my contention, regarding what was doing it, was right, and that it was not interrupted cooling water as the factory claimed. We find that 90 deg. on the outgoing cooling water gives best results, while the factory claims 130 deg. is the best.

I have also lessened my work by using a bronze needle instead of the factory made steel one, and make them myself. I also, after they have become worn and cut, turn off the suction valve stems and fuel plungers on fuel pump and shrink brass tubing over them, thereby renewing them at a very small cost whenever they get in bad shape. I also turned out the beaming on plungers and make new pins when needed and new brass bushing for the pins, so that my expenses on these high-priced articles are greatly reduced, also this allows me to make quick changes when such changes are necessary, owing to worn plungers. Yes, I've had my troubles, but I've learned that the trouble was with *me* and not the engine.

Asbestos in Place of Coal

IN A wood working factory with 312-kw. heating and powerplant, all steam pipes were given a covering of two layers of asbestos board ⅛ in. thick and a layer of 85 per cent magnesia covering. The saving was estimated as 22 tons of coal a year by cutting down radiation loss.

Bare pipe will give off 3 B.t.u. per sq. ft. of surface per hr. per deg. difference in temperature between steam and air. In this plant there were 111.25 sq. ft. of pipe surface, and a temperature of steam of 363 deg. F. The air temperature was about 100 deg, hence the difference was 263 deg. Hence $111.25 \times 263 \times 3 = 88{,}000$ B.t.u. was the loss per hr.

For a year of 120 days of 10 hr. each, and 180 days of 24 hr. each, a total of 5520 hr., this gives $88{,}000 \times 5520 = 486{,}000{,}000$ B.t.u. per year, and at 1192.5 B.t.u. per lb. of steam this calls for 407,500 lb. of steam condensed per year. The cost of steam in this plant was 20.9 c. per 1000 lb.; hence the cost of this steam condensed by radiation was $85.15.

As 84 per cent is the efficiency of magnesia covering, the saving would be $0.84 \times 85.15 = \$71.50$ a year; which reduced to a coal basis at $3.25 a ton, gives 22 tons as the equivalent coal saving a year.

FIRING COAL in small charges, particularly that containing much slack, reduces greatly the formation of a crust on the surface of fires and the need of breaking this crust.

Conservation of Ammonia---I

PRACTICAL ADVICE ON THE PREVENTION OF LOSS. PIPE LINES, OVERPRESSURES, AND ICE TANK COILS. BY A. G. SOLOMON

AT the present time the hardest problem that the refrigerating engineer has to solve is the saving of ammonia. This will not necessarily mean the operation of the plant with an insufficient charge.

Running any ice machine with too small a charge of ammonia is not economy. To remove heat units from water which is to become ice, or from produce in cold storage, requires the circulation of a certain amount of ammonia. Under ordinary operating conditions as found in the well equipped plant, each pound of ammonia will carry away and get rid of about 550 heat units.

This load of heat will vary somewhat, depending on the unnoticeable changing conditions of operation; but 550 units can be taken as a fair average load for each pound of ammonia circulated.

Liquid ammonia on its way from the condenser to the evaporating coils must not be allowed to take up any heat. Any heat units taken from the liquid before the expansion valve is reached means just so many more heat units possible to withdraw from the water or produce. So be sure that the liquid ammonia is cooled to the temperature of the coldest available water before it is passed into the evaporator. Insulate liquid lines where they pass through warm places or where they are exposed to the sun.

Next, after the load of heat is absorbed in the evaporator, the heat laden vapor must be protected from overloading in its passage to the ammonia compressor.

Suction lines must be well covered to prevent superheating of the saturated vapor. This precaution is necessary so that the compressor can handle the proper weight as well as volume of vapor.

By this we see that to produce results the necessary amount of ammonia must be in the system and in actual circulation and it must also be handled properly.

The question with which we are confronted is how to keep a sufficient charge of pure ammonia in circulation without adding any large quantities to the initial charge.

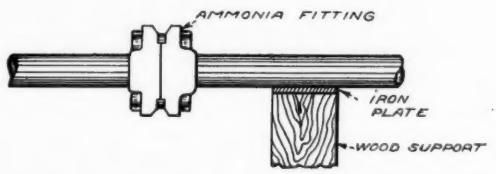


FIG. 1. IRON PLATE ON WOOD SUPPORT

First, loss of ammonia must be prevented. This is an everlasting job and neglect of strict attention will result in loss that may not be easily replaced.

REASONS FOR LOSS OF AMMONIA

CAUSES of loss of ammonia may be put under three distinct heads. First: Loss by rupture or the blowing out of parts of the equipment. Second: Continual slight leakage. Third: Introduction of foreign matter into the system, which will cause the ammonia to disintegrate.

The first reason is not met with as often as the second and third, but its disastrous results are more serious. A full charge of ammonia can be lost in a few minutes by the bursting of a compressor or by the failure of a fitting or other part of the pipe work.

To guard against such accidents a careful inspection of the entire plant must be made often and at regular intervals. Such an inspection will include everything that contains ammonia.

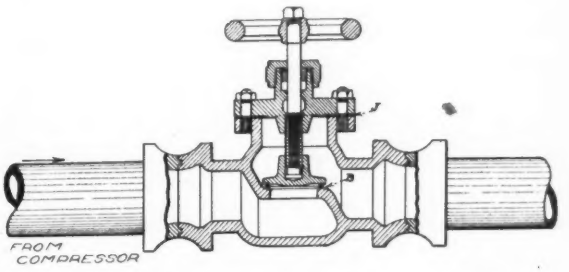


FIG. 2. PROPER PLACING OF VALVES ON DISCHARGE LINE FROM COMPRESSOR

WATCH THE PIPE LINE

THE WEAK point most often found is insecure hangers and braces for the pipe work. Liquid lines are noticed hung on walls or ceilings with heavy and properly designed strap iron hangers, which, on close inspection will be found to be fastened to rotten woodwork. It is not enough to see that the right number of good hangers are in place, but the material to which the hangers are fastened must also be good.

Discharge lines from the compressor to the condenser are usually securely fastened when the installation is made. Such fastening will remain good and safe for a long time, but the constant vibration will loosen the best of brackets and hangers. This loosening is frequent where the discharge line rests on wood. The heat of the compressed gas soon dries the wood and causes decay. Very slight vibration wears away the dry wood and in time the line is out of level, thus putting undue strain on the pipe and fittings. When wooden supports are used to carry a discharge line, an iron plate should be used between the wood and the pipe, Fig. 1. Anchor the line so that vibration is reduced as much as possible.

Never put up so-called temporary hangers on ammonia lines. Wire or rope is handy and almost necessary to support pipe work while erecting; but before turning pressure on the line, suitable hangers must be put in place.

Uncovered suction lines must be extra well supported as the accumulation of ice and frost will put additional weight on the line and may cause it to fall.

Direct expansion coils in storage rooms must also be supported properly to provide for the weight of ice and frost. Suction lines and freezer coils have fallen owing to the strain put on insecure hangers, so do not risk life and the charge of ammonia by neglect.

Safety Valve and Others

Rupture of fittings and pipe may be caused by over pressure. The only safe and sensible way to guard against such accidents is to provide safety devices such as will stop the machine when the condenser pressure reaches the danger point. A pressure attachment to the engine governor or circuit breaker will prevent accidents from high condenser pressure.

Safety valves should be on the discharge side of all ammonia compressors between the cylinder and the first stop valve. This will prevent rupture, if the machine should be started with the discharge valve closed or if an improperly placed valve should fail and plug the discharge. All valves on the discharge line between the compressor and the condenser should be installed with the pressure side of the valve closing toward the compressor, Fig. 2. Then if a disc comes off or the stem breaks, the valve will remain open. Placing

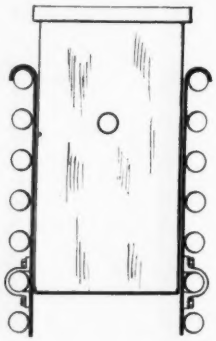


FIG. 3. IRON STRAP GUIDE WAYS FOR ICE CANS

of the valves in the wrong position has been the cause of numerous serious accidents.

The check valve in the discharge line and the pressure operated valve in the suction line are safety devices which guard against loss of ammonia in case of a ruptured compressor such as may result from a valve breaking and dropping into the cylinder.

When gage glasses are used on any part of the ammonia system, ball check valves should be used so that the ammonia will not escape if the glass breaks.

Another cause of rupture of apparatus is the imprisonment of ammonia. The expansion of ammonia is tremendous when heat is applied and if a means of escape is not provided, the imprisoned ammonia will exert sufficient pressure to burst its container. A shell and tube type brine cooler can be used as an illustration. The ammonia space is small compared with the evaporating surface. If, for any reason, a cooler is to be cut out of service for a time, the liquid ammonia must be pumped out before the outlet or suction valve is closed. Never close all the ammonia valves while there is liquid in a container if the container is in contact with any heat which is greater than the temperature corresponding to a safe working pressure.

Ammonia purifiers are dangerous when not properly installed or when handled carelessly. As heat is applied to drive out the pure ammonia and allow the impurities to remain in the purifier, some positive means should be provided so that overpressure and resultant rupture does not occur. The purifier should be equipped with a line extending to the ammonia condenser and a free working check valve. No cut-out valve should be placed in this safety line. Then in case of overheating the check valve will open and the pressure in the purifier will not exceed the condenser pressure.

Precautions for the Ice Making Plant

In ice making plants, where the ice tanks are equipped with coils, too much care cannot be exercised in the filling and lowering of cans. Often a can will become fastened on a coil and the ice puller will jar it loose so that it will settle into place. This is a dangerous practice as the can is liable to strike on a lower pipe and cause a break. Insecure hoists, cranes and can dogs may also allow a can to drop on a coil.

The loss of ammonia resulting from a burst coil in an ice tank is usually great. If the break is large, a lot of ammonia will escape before the coil can be shut off; and if the leak is small, it may allow leakage to continue for days or even weeks before it is located and repaired.

Often the engineer will allow what he considers a small leak in a tank coil to continue to the end of the season. No leak is so small that it should not be repaired at the first opportunity. The best rule is to fix the leak as soon as it is known to exist.

Another danger about leaking tank coils is the liability to draw brine into the system. In case of a bursted pipe or fitting on a submerged coil, it is best not to attempt to save the ammonia in the coil. Shut the coil off as soon as possible and if it can be done quickly, put an air pressure on the coil. The air will keep brine from entering till the cans can be pulled and the brine lowered so that the break is exposed. If brine does get into the coil, it must be blown out with air before ammonia is again turned on.

Every precaution possible must be taken to guard against leakage in the ice tank coils. The ice pullers must be given careful instructions in the manner of operating the cranes and hoists.

The entire ice pulling apparatus must be inspected by each ice puller when he comes on duty. He must look for loose nuts, bolts and set screws, defective cables and links, broken flanges on the crane wheels, and cable sheaves, loose or broken rails, can dogs that will not properly engage in the lifting holes and for any other defects that may be peculiar to the crane and hoist in use at that plant. This whole thorough inspection will take only a few minutes and must not be neglected. Even the slightest defect must be reported to the engineer in charge before a block of ice is pulled.

Now the reason for this inspection is simply to guard against the dropping of a can and the possible resultant leaking ammonia coil.

A 300 or 400-lb. block of ice dropping back into the tank and striking a coil is quite liable to start a leak if it does not entirely break a coil.

Hanging up of the cans that are being filled must be prevented. In most ice tanks, if the can is started in the right direction, it will settle down gradually as it fills. If there is no other way to prevent frequent hang ups, strips of strap iron must be fastened to the coils, Fig. 3. in such a way that the can will slide down on a smooth surface.

If a can is found sticking up in the tank after it is full, it must not be jarred or kicked loose. The crane and hoist must be used and the can raised from its resting place and lowered carefully.

Sometimes it happens that when repairing an ice tank coil it is necessary to place a flange in a position where the can will strike it. The safe way to deal with a case of this kind is to nail down the lid and not use any can in that place. When a leaking coil has been temporarily repaired with a clamp, the lid nailing should also be resorted to.

Even where there is no noticeable cause, leaks will develop in the ice tank coils. This leakage is usually slight and can be detected only by testing the brine. Litmus paper is convenient to use for testing brine or any liquid which is suspected of containing traces of ammonia. White litmus paper will change from white to pink or red depending on the amount of ammonia contained in the liquid into which the paper is placed.

Nessler's solution is the most reliable agent for testing the brine in ice tanks. The different ammonia manufacturers will supply this solution with directions for its use upon request. Such an offer should be taken advantage of by all managers and chief engineers of ice plants.

Test the brine every day and upon the slightest proof of a leak the defective coil must be located and the leak repaired.

In past years, it has been common practice to overlook a small leak that was hard to get at to repair. Now it is the engineer's particular duty to stop the leaks and save the ammonia.

Annual Gas Engine Association Convention

THE ELEVENTH annual meeting of the National Gas Engine Association has been announced for June 3 and 4, to be held at the Sherman Hotel, Chicago. Secretary H. R. Brate announces that the program has been about completed and that it will be timely and cover business of particular interest to the trade at this time.

On Monday forenoon, there will be a joint meeting between the association and members of a committee from the National Federation of Implement and Vehicle Dealers' Association, for the purpose of discussing the matter of repair parts. Repairs for gasoline engines, their cost and the prices to be charged for them, constituted one of the matters that came up for discussion at the last annual convention. Repairs and their costs are subjects about which the dealers' associations throughout the country have thought a good deal. Most dealers and dealer association officers have very pronounced views, and so have the manufacturers. It has been the experience of many manufacturers that when a meeting of this kind was held, it was possible for manufacturer and dealer to arrive at a basis of common understanding, and it is expected that such will be the case at this convention of the gas engine trade.

In the afternoon, the subjects will be as follows:

"The Iron and Steel Situation"; suggestions, prophecies, etc.

"Government Requirements on Gas Engines and the Method of Handling those Matters at Washington."

"The Labor Situation."

"The Fuel Problem." This will be handled by a representative of the Federal Fuel Administration.

On Tuesday forenoon, the following papers will be read:

"What is the Future of the Farm Gas Engine Business, in View of the Tractor Eliminating the Portable and Larger Sizes?"

"Sizes to Manufacture from the Manufacturing and Sales Standpoints."

"The Present Condition and Future of the Gas Engine Export Trade."

On Tuesday afternoon, there will be a technical session in connection with the Mid-West Section of the Society of Automotive Engineers. Several papers of a technical nature will be presented and discussed.

In the evening, there will be the annual dinner of the association, followed by a "War Service" session, the time of which will be devoted largely to patriotic matters.

As is quite generally known, all meetings of the association are open to anyone interested and everyone is invited to attend.

The Double Effect of Economy

WHEN AN AMERICAN CITIZEN, instead of spending $100 for something he wants, denies himself and lends the money to the government, he performs a double service.

First, he furnishes the government with $100 to use in the prosecution of the war.

Second, he has relieved to the extent of $100 the drain on our "goods and services"; that is, materials and labor. To make the article or articles he would have bought, or to manufacture others to take their place in the market, would require materials and labor. In addition, to get the article to him labor and freight space would be required. By doing without the article, he has left free a certain amount of material to be used for war purposes, a certain amount of labor to be used in the same way, and he has also relieved to a certain extent the transportation facilities of the country.

This may not be much in the individual case, but when hundreds of thousands and millions of Americans pursue this course it means millions and millions of dollars loaned the government, tremendous quantities of materials left for uses of the nation in this war, millions of hours of labor free to do war work, and a vast amount of freight space free for national uses.

These sacrifices are easy to make; are small and trivial compared to the sacrifices that our soldiers and sailors make daily while they offer constantly their lives for their country, the greatest sacrifice of all.

Fighting Coal Fires in Storage Space

IN commenting upon methods recently employed for extinguishing coal fires, an article in the Travelers Standard states:

Up to the present, the experience of nearly all handlers of coal in large quantities goes to show that the most positive and satisfactory method of extinguishing fires of this kind consists in turning over the coal and thoroughly saturating it with water. If, in piling up the coal after the fire has been extinguished, the piles are not allowed to exceed a height of 10 to 12 ft., it is improbable that fires will recur from the same cause. In addition to limiting the height of the piles, they should also be confined to a ground area of such proportions that no point in the interior of a pile will be more than 10 ft. from an air-cooled surface.

Much time and water have been wasted in attempting to extinguish fires in large coal piles by pouring water on the external surfaces of the piles. This method is usually unsuccessful, because a coking action takes place in the region immediately surrounding the fire, and thus a crust is formed through which water will not penetrate.

It has been suggested that lines of perforated pipe might be laid on the bottom of coal bins (or along the ground, when coal is stored in the open) before the coal is dumped into the bins, and that water might be forced through these perforations and up into the interior of the coal piles, in case of fire. This appears to be a more suitable method than pouring water upon the *outside* of the piles; but we have had no experience with it, and there may be practical difficulties that would militate against its success. A similar arrangement consisting of pipes through which *steam* might be liberated in the interior of coal piles, would perhaps be even more efficacious.

Another suggestion is that cylinders of compressed carbonic acid gas, fitted with fusible plugs, be distributed throughout the coal pile. Then, in case the coal becomes ignited, the fusible plug will melt in a tank near by, and the gas will escape from the cylinder and extinguish the fire.

Coal bins are sometimes divided into several compartments by means of heavy brick or concrete partitions which act as fire walls and prevent fires in the coal from spreading. In cases where large quantities of coal are stored indoors, such an arrangement is to be recommended. With indoor storage, the tendency is to fill the bins to their capacity, and in doing this the possibility of spontaneous ignition may be greatly increased, in the opinion of some engineers. The reasons for this are, first, that the safe height for storing may be exceeded in filling the bins, and second, that the ventilation is necessarily more restricted than when the coal is stored in the open, or simply with a shed roof over it. Those who hold a contrary view, however, express the belief that if the bins are airtight (or nearly so) on the sides and bottom, the air necessary to support combustion can enter only from the top, and in small amount, because of the closely-packed coal. Moreover, by removing a portion of the coal at the top, the bin may be filled with water, thus effectually preventing the entrance of any air whatsoever.

Fires caused by spontaneous ignition in coal piles have been unusually numerous during the past few months, and the general opinion appears to be that they have been due to the inferior quality of the coal. In many cases such fires are considered to be unavoidable, and no special efforts are made to prevent them. Under the present conditions of coal transportation and supply, and the consequent need for conservation in every possible way, any and every suggestion for checking such waste that appears to be based upon practical principles should be carefully considered and acted upon.

Buy Thrift Stamps Now

"THE TIME when every man, woman and child must do his share to help win the war is not coming.—It is here!"

Self-indulgence,—frittering away funds that Uncle Sam needs to help back up our forces is aid to the enemy. And careless spending of even small amounts is disloyal to our own futures as well as to our country.

To earn,—to save all except what we need for comfortable (not indulgent) living,—to consider carefully whether our expenditures are wise and bring full return,—and to invest the savings with our government; these are our war time duties.

And this course is also a simple, sane foreguarding for the future, which will benefit us as well as help our soldiers and sailors.

Everybody can save something. But it should be done systematically and regularly. And the Thrift Stamp Pledge is the easiest way.

We urge that you pledge yourself for some definite amount during 1918,—and then strive to exceed your pledge as much as possible.

Thrift Stamps can be had at any bank or postal station—or probably from someone in your own office.

When you have filled a Thrift Stamp card,—16 stamps,—for a few odd cents extra, you can exchange the Thrift card for a War Savings Stamp. This stamp which has cost you a little over $4, will be worth $5 on Jan. 1, 1923, the government paying 4 per cent interest.

It is hoped that you will hold the Stamp until that time, but in case of absolute necessity, you can present the stamp at any post office, with a written request, and after 10 days you will receive $4 plus interest at 3 per cent from Jan.1, 1918 to the date of your request.

Now,—today is the best time to start. Help yourself, help your country, help your Army and Navy.

SOME TESTS were carried out in the Laboratory of the University of California on the water-tightness of plaster "shot" on the dam face with a cement gun. Several plaster slabs, from ⅜ to 1½ in. thick, made at Gem Lake, were tested with water pressures ranging from 700 to 1600 ft. for several hours, with no moisture coming through the slab. One 1-in. slab held a head of 1610 ft. for 2½ hr. without showing moisture, then the water pressure was raised gradually to 3400 ft., and the specimen broke in bending, having leaked a little just before breaking.

Practical Ideas for the Plant

ADOPTING the scheme employed in pool halls for keeping tally on the game, I have a convenient means for keeping tab on the amount of oil used. A rod carrying washers is placed near each oil storage tank and for each vessel of oil taken a washer is pushed to one side.

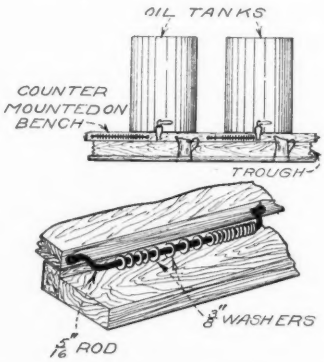


FIG. 1. KEEPING TAB ON OIL USED

Each day the washers representing vessels of oil used are counted for our records and returned to one end of the rod ready for another day's record. When the vessels used are quart measures, every fourth washer is painted red, making it easy to count up the number of gallons. Where gallon vessels are used, it is more convenient to distinguish every fifth washer by painting it red.

Sometimes a gear, pulley, bushing or some other part will not fit the shaft it is to be put on and if it is only a few thousandths of an inch too small, it can be lapped out as shown in the sketch, Fig. 2, the lathe running at a good speed. The lap can be made of steel, brass or hard wood and when coated with emery dust and oil will grind quite rapidly. The gear is held from turning and worked back and forth on the lapping tool by the hands and the lapping tool is spread to take up the wear by means of a tapering wedge driven in one of the slots.

Pipe line hangers for big pipe in factories or engine rooms can readily be made as shown in the sketch, Fig. 3. Two straps of bar iron support the rollers which allow the pipe to expand and contract with changes in temperature without undue strain upon the hangers. Two forms of rollers are shown, one being a pipe which rolls upon a bolt support, the other a pipe fitted with a cap at each end and rolling in a hole in the bar iron.

An emergency drill may be made by flattening out the end of a drill rod into a diamond shape as illustrated, then tempering and grinding the edge.

It frequently happens that the slot in the end of a screw is too small for the screwdriver. When the slot made by a single hacksaw blade is too small, two may be used in a single frame. This will make a good, wide slot with little difficulty. C. C. SPREEN.

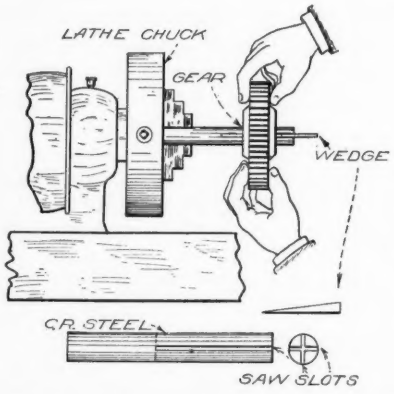


FIG. 2. LAPPING OUT THE BORE OF A GEAR WHEEL

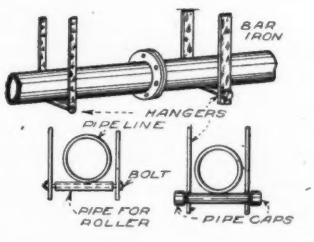


FIG. 3. TWO FORMS OF PIPE HANGERS

Pumps and Their Troubles

DURING my long experience with pumps I have always found that when a pump had any show whatever it would work. I was called to a pump station where a pump failed. When I got there the attendant had the pump dismantled with valves all out. The first thing he told me was that the valves were no good. I saw nothing wrong with them, so I told him we would put them back and I would see if I could locate the trouble. I examined the water end and found the packing good. With 60 lb. of steam pressure I opened the throttle, but the pump failed to move. In the discharge line was a globe

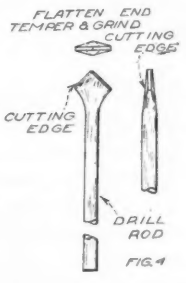


FIG. 4. AN EMERGENCY REAMER

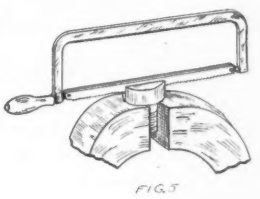


FIG. 5. USING HACKSAW WITH TWO BLADES

valve near the pump. I unscrewed the valve disc and turned on steam; the pump started up and threw water everywhere. I stopped the pump and put the valve disc back, tried it again, but it would not move. There was also a globe valve in the discharge line under the water tank and to keep people from opening it the wheel had been taken off, so it was opened and closed with a wrench and finally the valve stem was broken off with the valve closed. So there was nothing wrong with the pump and it is always easy to find the trouble if you know how.

On taking charge of one plant, I found the feed-water pump was working under a heavy strain. I was told it was steam-bound and that if I open the bleeder once in a while and let out the vapor from the hot water it would be all right. But I knew the discharge pipe was giving the trouble, so the following Sunday I washed the boiler and disconnected the pipe and found the ell where it is connected to the boiler almost closed with the hardest kind of scale. It certainly looked impossible to get water through so small an opening to feed a 100-hp. boiler. I put in a new ell and that settled that trouble.

On a feed-water pump I am running, in order to cut expenses, I decided I would bring the feed water through the exhaust pipe which is 35 ft. long. By the time the water enters the pump it has a temperature over 200 deg. and will cook an egg in 6 min. A heater between the pump and the boiler makes it still hotter. After making this change the pump did not act as before; it seemed that the suction valves would not hold the water, so I had to double the speed of the pump. The valves became very noisy. I happened to have some sheet lead ⅛ in. thick. I cut a lead washer almost the size of the valve and placed one on each valve. This made the valve spring shorter and stiffer and I screwed the valve studs down tight, in fact I thought I had them too tight; but when I started the pump the noise had all ceased and I have never seen a pump handle water any better. The pump was built to handle hot water, but I believe the builder did not know how stiff the springs should be or he would have made them larger and stiffer.

W. B. CRAWFORD.

Receiver Pressures

HAVING HAD considerable experience with compound engines, I was quite interested in the article on that subject by Chas. J. Mason in a late issue of Power Plant Engineering.

In conversation with the late E. Francis Crowell, of the Wm. A. Harris Steam Engine Co., this gentleman stated that it was the practice to recommend a receiver pressure 2 or 3 lb. less than the high-pressure terminal as shown by cards taken from such an engine.

The reason we use compound engines is to enable us profitably to expand steam through a greater range of temperature than can be done in a simple engine; and by using two cylinders the range of temperatures is less in each than when the expansion is carried out in one and again we get the benefit of the re-evaporation in the high-pressure cylinder.

The way I obtain the receiver pressure when the load is comparatively steady and the engine proportioned to its work is this:

If the initial pressure is, let us say, 135 lb. gage, or 135 plus 15, or 150 lb. absolute, the temperature is, according to steam tables, 358 deg. F. and exhausting into a 27-in. vacuum the corresponding temperature of which is 115 deg. F., we have a total temperature drop of 358 minus 115, or 243 deg. F. If we are to have an equal drop in temperature in each cylinder, we have 243 divided by 2, or 121 deg. drop in each.

If we take our initial high-pressure temperature of 358 deg. F. and subtract from it 121, we have 237 deg. F., as the temperature of the high-pressure exhaust which corresponds to a gage pressure of 9 lb., or 24 lb. absolute. Assuming no drop between high-pressure exhaust and low-pressure initial, we have 237 minus 121, or 116 deg. F., the temperature corresponding to a 27-in. vacuum.

In practice, some drop in pressure will exist between high-pressure exhaust and low-pressure initial and corrections will be required accordingly.

I am well aware that there are circumstances when this method cannot be followed.

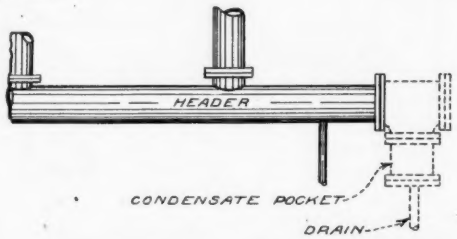
It is a good plan to secure a scale to the governor column with a pointer attached to some part of the governor mechanism to move over this scale; then adjust the receiver pressure until that value is found, which allows the governor to travel in the highest position, because then the governor is cutting off as short as possible under the existing conditions.

Any change should be made slowly and results carefully noted, because in some cases some time will elapse before any results can be seen and relied upon as representing conditions after the previous change.

RECEIVER.

Improving Drainage of Steam Header

BECAUSE OF the increased load placed on the boilers in a small plant, considerable trouble was experienced because of excessive moisture carried out of the boilers with the steam. As a result, the 1-in. drain which was placed in the steam header and which drained the header satisfactorily under normal conditions, was not of sufficient capacity to care for the increased amount of water, especially at those times when slugs had to be handled.



SCHEME EMPLOYED TO DRAIN HEADER

The header was made up of 12-in. pipe with blank flanges on each end and the matter of handling the water was satisfactorily taken care of by placing at both ends of the head a tee and drip pocket as shown in the accompanying sketch, this addition being made possible by simply removing the blank flange on each end and incorporating into the header the fittings shown. Besides furnishing added drainage capacity because of

the 1-in. drain from each drip pocket, the pockets served as reservoirs for storing up any slugs of water until the traps were able to handle them. When not acting as the water reservoirs, these two additions gave added steam storage capacity to the header—also a desirable feature under the existing overload conditions.

M. A. SALLER.

Hiring and Holding Men

THE EDITORIAL on Hiring and Holding Men prompts me to suggest a few rules that I follow. I generally try to find out what a man's reputation is among his fellow engineers before hiring him, if it is a trained man I want. If a man stands well with his fellow tradesmen he is generally all right. When wanting a man I am most likely to ask the men in the plant if they know of one who can fill the position; if the answer is in the affirmative, they are asked to bring him in so we can talk it over. I find this method satisfactory. If in need of an unskilled man I go about it in the same way and most of us can tell in a short time what is in a man.

I have one way of judging a man that seldom fails and that is how he gets into the game on a repair job. The fellow who can never see the next move and who has to be told before he makes an effort to help shows either that his mind is not on the job or he is lazy or stupid. The fellow who will make you a good man, usually, is the one, who, when you want a wrench or whatever it may be next will be handing it to you the moment you need it or will be ready to help when he is needed without being told.

A number of years ago, I picked up off the yard gang a laborer to help me repair and set up an engine. This man was right off the farm, but the way he hooked on convinced me he possessed ability and I kept track of him and took him in the engine room. Time showed that I had properly sized him up. He stayed with me 10 yr., then took charge of a plant on his own hook.

As to holding men, I don't know much about that; all the important positions are held by men who have been with me for years. I always put new men on at the bottom; if there is a better job, it's a promotion and we put on a new coal passer; likewise, for my own peace of mind practically all of those who have been there any length of time can be shifted in an emergency to any job and hold it down.

The way a concern treats its employes has most to do with holding men; a niggardly policy means changes. A shop with a reputation for treating its employes fairly always has the pick of the labor market and has the least labor turnover.

It is the chief's business to see that his men get as good pay as the men in any of the other plants; to see that they are not imposed on by anyone, high or low; to show them that he is not afraid to go anywhere he sends them and can do any job he asks them to do; also to let them know that he puts them at no job so hard or dirty that he is afraid to get into it himself if necessary.

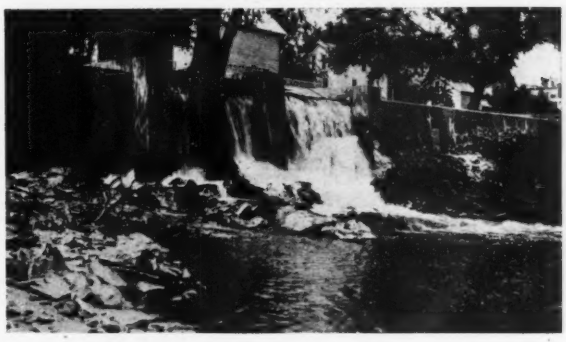
I have heard a remark made several times during the present labor scarcity that you had to be careful how you talked to your men these days. Now, that made no difference to me. I try always to speak right to my men; there is no other way to get good work out of good men and you want no other, regardless of whether labor is scarce or plentiful. I wouldn't cringe before a man if the whole plant shut down; neither would I take advantage of a man's necessity to abuse him. As a result, I feel that I have the best crew in the state.

J. O. BENEFIEL.

A Broken Flume

THE CEDAR VALLEY Electric Co. has a small hydraulic power plant at Charles City, Iowa. The cement and stone dam gives an effective head of 9 ft. The power house is located down stream about 500 ft. An enclosed flume of reinforced concrete carries the water to the wheel pit. From the first, this flume has been too small to carry enough water to keep the wheel pit full, even with but two of the three wheels running.

In the spring of 1917 the water in the river was very high. Before the water receded a couple of fountains were noticed in about the middle of the flume. The cut shows the amount of damage to the flume. One opinion was that the tree had raised the flume and weakened it. A concrete expert, however, stated that the trouble came from improper reinforcement. The latter seems more probable. Besides the small size of



WATER RUNNING THROUGH BROKEN FLUME AT CHARLES CITY, IA.

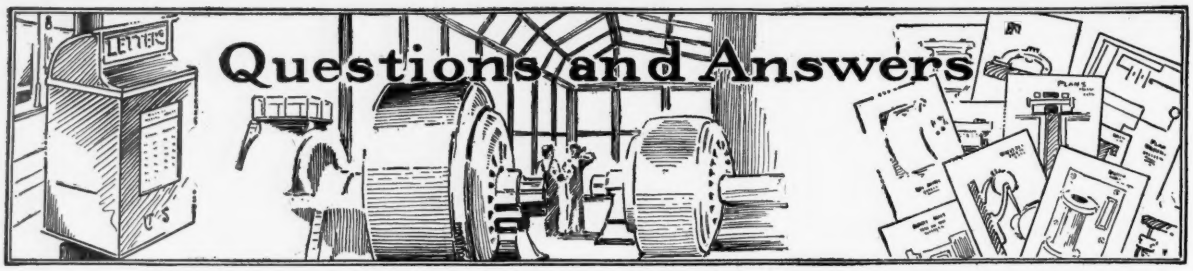
the flume made water hammer a common occurrence. This probably helped to weaken the flume.

In any case the accident shows the necessity of large water passages and ample reinforcement in concrete work.

C. V. HULL.

EVERY SHREWD INVESTOR—every wise property owner, every sane workingman—knows that the safety of all persons and of all property in the United States rests on the safety of the United States as a sovereign power. If the United States is lost, every dollar of our invested capital is depreciated or entirely wiped out.

We are engaged at the present time in a desperate war. The issue is our right to remain "free and independent." If the military tyrant of Europe beats us we must be his vassals and his slaves. To whip him and retain your liberty and to insure our independence, we must win a complete victory over Germany. If we fail, our mortgages and flats are worthless. The moral is: Invest in Liberty Bonds and Win the War!



Electrical Problems

IF 550 V. DIRECT-CURRENT were delivered, how could this be reduced to 80 v. without a motor-generator?

If this were reduced by the resistance method, how much resistance would it take and what size iron wire would be sufficient to carry 250 amp.?

2. If a compound-wound generator was running and enough resistance was added to the shunt field winding to cut the voltage down to 80 v. at 250 amp., what effect would this have on the machine?

3. If a compound generator was run as a series generator with shunt field open, what effect would this have on the machine? If run as a shunt generator?

4. Can a liquid rheostat be made so that the solution will not freeze? F. H.

ANSWERS

WE ARE SORRY that we cannot recommend any method of converting from 550 v. to 80 v. without the use of a motor-generator. If you should attempt to cut down the voltage by the use of a resistance, you will be using up 470 v. on your resistance, and only 80 v. on useful work. This would mean that you would have to have a resistance, when carrying 250 amp., of 1.9 ohms, and when you are carrying any lower current, you would have to have a correspondingly higher resistance in order to keep the voltage at the end of the line down to 80.

The result would be that you would be using up 118 kw. on your resistance and using only 20 kw., so that you are wasting about six times as much energy as you are using. This is obviously a bad thing to do, unless it would be for a very short period of emergency work, when you could not possibly get the results in any other way.

2. As to cutting down the voltage from 550 to 80 by putting resistance in the shunt field, it could not be done. The most you could vary the voltage without getting a very unstable condition would be 75 or 80 v.—that is, you might reduce to 475 v. by using a shunt field resistance, but that would be about the limit.

3. If you use the compound winding alone, cutting out the shunt winding, it is not likely you could get more than 30 or 40 v. at the outside and you would have a series-wound machine in which the voltage would run up rapidly with any increase in current and fall off rapidly with any decrease in current. Using the shunt winding alone, your voltage would be around 500 to 520, depending on the amount of the compounding. The only satisfactory method for handling your proposition is the use of the motor generator set, with a 550-v. motor and an 80-v generator.

4. As to making a liquid rheostat so that the solution cannot freeze, this is impossible, as when you put in enough salt—either sodium chloride or calcium chloride—to make a non-freezing mixture, you get the resistance lowered so much that its value as a rheostat is practically destroyed. For a condition where freezing is likely, the only thing to do is to use cast-iron grids in the form used for field resistance in large alternating-current machines.

Vacuum Pump Unsuitable as a Boiler Feeder

WHY CAN NOT a vacuum pump be used for boiler feeding purposes?

2. If by running condenser, a saving of from 20 to 30 per cent may be realized, will compounding add to these figures? If so, how much?

3. Why is the power factor of a 220-v. four-wire system lower than that of a 220-v. three-wire system?

4. Where does the study of physics appear in steam engineering? Give an example.

5. For what purpose are the small holes found in the cylinder of a duplex boiler feed pump? E. O. L.

ANSWERS

THE VACUUM PUMP is not properly proportioned for use as boiler feed—that is, the steam cylinder is not large enough in proportion to the water cylinder. Another thing, the valves on the water end are usually not of the right material to stand high-pressure work, and the springs on the valves are not sufficiently strong to seat the valves quickly. The vacuum pump is usually designed without any air chamber on the water end, and this is always a desirable thing to have in a pump which is to work under high pressure.

2. Compounding will increase the saving in the case of an engine run condensing. The amount of saving depends on the initial boiler pressure carried and the vacuum carried, but will run probably from 8 to 10 per cent.

3. Power factor on a system depends more on the load than it does on whether it is a four-wire or a three-wire system. The four-wire system usually carries a two-phase induction motor, which has a much lower power factor than a three-phase motor, such as is used on a three-wire system. This is where the loss in power factor comes in. In a system properly designed, there is no reason why the transmission line for a four-wire system should have a lower power factor than the three-wire system. The difference in power factor in the motors comes on account of the difference in the distribution of the wiring on the motors.

4. Physics is the science of natural forces, and includes the laws of all natural phenomena. It deals,

therefore, with the mechanical forces that come in in strength of machinery, with the effect of heat on steam, and the transformation from heat into mechanical energy, with the combustion of fuel, and the transfer of heat from the gases to the steam, and at every step in all engineering work, we are using the laws that have been investigated and formulated by the scientists who have developed the science of physics.

5. We cannot answer this question without knowing more definitely where the holes that you refer to are located, and what kind of a pump you have in mind. Different forms of pumps have ports—some of them compression ports, some of them auxiliary ports for operating the main steam valve.

Defining Load Factor

PLEASE DEFINE and tell me how to figure the following: Load factor; machine load factor; and plant load factor. W. L. S.

A. The load factor of a machine, plant or system is the ratio of the average power to the maximum power during a certain period of time. The average power is taken over a certain period of time such as a day, a month or a year and the maximum is taken over a short interval of the maximum load within that period.

In each case the interval of maximum load and the period over which the average is taken should be definitely specified, such as a "half-hour monthly" load factor. The proper interval and period are usually dependent upon local conditions and the purpose for which the load factor is to be used.

Pumping Costs

WE ARE OPERATING a 10-ton ice plant. The water for cooling the ammonia and for condensing steam is supplied from a well by a 6 by 5¾ by 6-in. Gardner duplex pump. The pump is down in the well, 20 ft. below the surface and within about 15 ft. of the water. From the pump the water is raised 60 ft. Normally the pump makes about 40 strokes a minute and is run only when the ice machinery is in operation. Now, what is the approximate cost per 1000 gal. of running this pump with steam at 100-lb. pressure, soft coal at $4.50 per ton being used for fuel? The steam is supplied by the ice plant boiler.

Our well has given out and we must either put down a new well or buy our water from the local water plant. The question is, which would be the more economical? The cost of a new well would be about $300.

Under the above circumstances, what could we afford to pay the city per 1000 gal. of water? M. T. B.

A. I have made some computations on probabilities in your plant, which I think will give you an indication of what you are after.

At 40 strokes per min. in each cylinder, your duplex pump would be handling about 50 gal. per min., and allowing 80 ft. gross head, which is 5 ft. for pipe and valve friction, this pump will require about 0.9 hp. on the steam end.

If we allow 120 lb. of steam per hp.-hr., this will call for 108 lb. of steam per hr., or about 0.036 lb. of steam per gal. of water pumped. For 1000 gal. this would give 36 lb. of steam.

If we assume that 7 lb. of steam are evaporated per lb. of coal burned, this would give about 5 lb. of coal used per 1000 gal., which, with coal at $4.50 a ton, would make a cost of 1.128 c. per 1000 gal. for fuel.

I have assumed that with a well costing $300, the interest, upkeep and depreciation would amount to about $50 a yr., and probably about the same amount would be necessary for the interest, depreciation and upkeep allowance on the pump and piping. If we assume that 2,500,000 gal. are pumped per yr., this would be a cost of about 4 c. per gal. for the well, pump and piping, or a total of about 5⅛ c. per 1000 gal. for fuel and upkeep. I have assumed that no extra labor would be required in the plant, on account of the use of the well and pump.

With these assumptions, which are probably not far from correct, you could pay any price up to 5 c. per 1000 gal. for the city water and it would be profitable to do so. Beyond this amount, it would probably be cheaper for you to install a new well and pump your own water.

Relative Pump Economies

WE HAVE a 50-hp. Standard Westinghouse Engine, supplied with steam from a 100-hp. boiler fed by means of a Metropolitan Injector. We intend to head our feed water with exhaust steam in a National Feed-Water Heater and wish to inquire whether it would be more economical to employ a belt driven pump belted to the engine shaft or a direct-acting steam pump.

Should the water, which is taken from the city mains, be allowed to flow into the heater and from there pumped into the boilers, or should we pump from the city mains through the heater and into the boiler? C. S.

A. As a rule, the belt-driven pump will be more economical than the direct-acting steam pump, so far as power is concerned. The steam pump uses a large amount of steam per hp.-hr., and its advantage is that it can be regulated readily to meet the need for more or less feed water in the boiler.

The belt-driven pump must run practically at a constant speed, and the only way of regulating the water fed to the boiler is by a bypass valve which will allow more or less of the water pumped to flow back into the suction.

Another method would be to have some kind of a clutch between the engine shaft and the pump, so that it can be stopped and started as may be necessary to keep the water level correct in the boiler. As you probably have all the exhaust steam you need from the engine to heat the feed water, there is no advantage in having more exhaust steam from the pump.

As to the plan of forcing the water through the heater by city pressure, or taking the city water into the pump suction and pumping it through the heater, we would favor the latter plan. There is no advantage so far as power is concerned, one way or the other, but your pump will operate better when handling the water direct from the city mains than if handling the hot water direct from the heater. You can have a bypass around the heater from the pump, so that in case it is necessary to make repairs on the heater, the boiler can be fed direct from the pump and avoid shutting down the plant.

POWER PLANT ENGINEERING

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Get Ready Now

If you had an official letter from Washington, stating that from now until April 1, 1919, you could get only 75 per cent of the coal that you burned for the corresponding year past, what would you do?

That is practically the condition that exists, although Washington has not put it quite so bluntly, except in the case of anthracite coal for domestic supply. The requirements of the country will be 700,000,000 tons. The best possible output of the mines would be 600,000,000 tons, and, at present, the mines are operating at an average of not over 80 per cent of possible output, due to lack of cars, lack of orders and labor shortage. With all possible care, the country will be 100,000,000 tons short of its needs. Unless all of us cooperate to help out, the shortage may reach 250,000,000 tons.

What can be done?

In the first place, after last winter's experience, there is no excuse for any coal user who does not buy and store as large a part of the coal needed for next winter's use as he possibly can. Fill all the bins, hire vacant land and store in the open. Borrow money if necessary to pay for the coal. But use every effort to get that coal. If you don't you have only yourself to blame for what troubles may come.

Next, cooperate with the Government in every way to keep railway tracks clear and cars moving. Coal cars may be blocked by trains of other material, and the result is the same as if the coal cars were delayed at mines or power plants.

Third, use your influence to favor every movement for utilizing water power to the utmost, and water ways as far as possible to relieve the railroads.

And last, but not least important, get ready now to use every possible heat unit of every pound of coal that you burn. Cut down waste in the furnace, in the ash pile, at the stack, at the exhaust. Heat units are precious. Every one saved now means less shortage next winter and greater production towards winning the war. Every man is a soldier fighting in the industrial army for success. He may fight well or badly. Your boy "over there" may owe his life to the supplies and munitions that this country can send, because everybody has saved coal and kept the plants running. He will fight well if he has the means. How are you going to fight?

Transportation

At first thought, transportation seems to have little connection with stationary power plant operation; but when we look back to the heatless days of last winter, and realize that lack of transportation was the direct cause of them, the importance to the power plant manager of helping to solve the carrying problem becomes clear.

And, also, it is well to remember that some 800,000 cars and 27,000 locomotives are employed in hauling bituminous coal, of which 40 per cent is used in power plants, so that an appreciable help in increasing the effectiveness of our railroads can be given by care in the loading, routing and unloading of cars that supply our plants with fuel.

The things we can do to help are: Boost for improved highways which will admit hauling heavier loads by motor trucks and teams; work for improved waterways

and secure shipment of coal by barge where possible; buy coal from the nearest suitable mine; have it sent by the shortest route, without reconsignment; and unload all cars as soon as possible after receiving them; co-operate with the shipping department of the works to help get cars set in place unloaded, loaded to full capacity and on their way as soon as possible.

The ideal is to have every car moving all the time except that absolutely necessary for loading, unloading and repairs.

If everybody pitches in to help all he can in solving the problem, it will go an appreciable way to avoid heatless days next winter.

Editorial Comments

POWER FOR SWITCH YARDS of a large railway system demands that the power plant take the nature of both an isolated and a central station plant, in that many of the services performed by the plant are special, requiring both steam and electric power. At the same time, much of the load placed upon the plant is for the lighting of the yards and the operation of signalling systems at considerable distance from the plant. Therefore, while the alternating current is developed at comparatively low voltage it must be stepped up to an economical voltage for transmission. In the leading article of this issue is described one of the most modern and well equipped plants for supplying a large railway yard with power and heat, and although this plant is not large, it will be noted that it is well equipped with modern equipment for saving heat units and labor, and giving to the yards a continuous, uninterrupted source of power.

FIRING BOILERS BY BRAIN POWER is not a new occupation for most readers of Power Plant Engineering, and no one depreciates the advantages of using reason in the handling of boiler furnaces. Nevertheless, it is seldom that such a full equipment of instruments for handling boiler rooms is provided as that described on another page of this issue, and there is much yet to be learned in the way of handling boiler rooms under the direction of instruments rather than the judgment of the fireman, no matter how skilled he may be.

THE EFFECT OF ASH ON EFFICIENCY of the power plant furnace can readily be calculated if the proper data are obtainable. To those engineers who have been compelled to report less evaporation per pound of coal during the past year than the previous year, we would suggest for their own consolation that they figure out the efficiency of their boiler as is suggested on another page, substituting, of course, data secured from their own conditions.

ELECTRIC MOTORS are continually being changed in design to meet newly encountered industrial conditions, and it is with the idea of keeping readers informed upon the selection and characteristics of modern standard motors that the article by Mr. Fox is published. It will be noted here that but little change has been made in the electrical features of direct-current motors in the past 10 yr., but quite marked changes in magnetic and mechanical features have taken place. These features undoubtedly make them better suited to the special work for which they are designed.

POWER PLANT DOCKS will probably be more in use this summer than ever before, as we anticipate power plant owners will store more coal than has formerly been their practice. It is more than likely that the work of building such docks where none have thus far been provided will fall to the lot of the engineer, and for his convenience, Mr. von Fabrice gives rather detailed instructions how this work may be done.

MASTERING A DIESEL ENGINE, according to Mr. Pierce, can be done, but it requires a lot of patience, ingenuity and all kinds of experience with trouble before one can feel confident that the engine is completely under his control. Told in a way that is extremely interesting, the story of Mr. Pierce's experiences should be of benefit to masters as well as novices in Diesel engineering.

CONSERVATION OF AMMONIA is, by government edict, a necessity this summer in ice making and refrigerating plants. In this issue Mr. Solomon begins a series of articles giving practical hints for saving or conserving ammonia, and the suggestions made by the author, based upon long experience in the field, should, if followed, aid the engineer in keeping within the limits of Government requirements.

Can You Afford It?

LISTEN TO WHAT DEMOSTHENES SAYS

"UNCLE SAM can borrow anything and everything I have." That's the answer of a 100 per cent American. His name is Demosthenes Anagnostopoulos. He has two brothers, Antoneos and Stavros, and they own a small candy store in Wisconsin. Demosthenes puts it this way:

"We boys didn't have anything when we came to this country. All we have we made here; we owe it to this country.

"We don't consider we have done anything but a fair share. We took $1600 of the Second Liberty Loan, and our allotment of the Third was $100 each, figured on the appraised valuation of our property. But we knew Uncle Sam wanted to raise much money, and we knew that it is a safe investment, for it has the whole wealth of the United States as security. So we talked it over, and decided that we owed this country something — yes, everything — and the least we could do would be to lend all our savings to the Government.

"Tony is in the draft and will probably go on the next call. He is glad of the chance to fight for his country. Stavros and I, we are glad to have him go, and we, too, will be glad to go if we are called.

"We don't consider that we are specially patriots to lend money to the Government. In the 16 yr. we have lived here, we have prospered. America gives every industrious man a splendid opportunity. We want that to continue. That's the real reason we subscribed."

Now—what more can you add to loyalty than that? To lend everything you have—savings, family, life to Uncle Sam. And it makes no difference whether you were born here, were brought here or came here, you owe everything to this United States.

Have you bought your full share of Third Liberty Loan Bonds?

POWER APPARATUS IN SHOP & MARKET

NEW IDEAS IN MAKING BUYING AND SELLING

Tuxeda Swing Joints

THE Tuxeda Swing Joint shown herewith in section and applied to a sole heating press depends upon a fibrous packing for a tight joint. The packing is kept under constant pressure by a spring which automatically compensates for wear and keeps the joint tight until the packing is completely worn out. A feature of

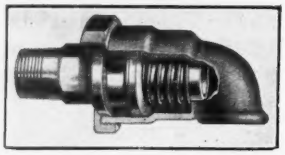

FIG. 1. INTERIOR SECTION OF TUXEDA SWING JOINT

the fibrous packing used is that under conditions of extreme temperature change, the packing will readily adjust itself to the gland chamber, despite the difference of expansion of various parts, so that for alternate steam and cold water service this connection tends continuously to hold a tight joint.

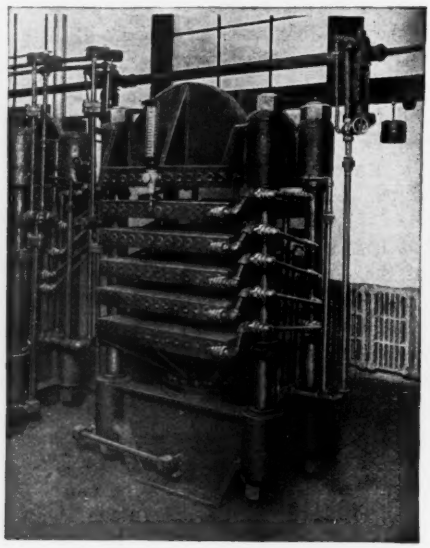

FIG. 2. APPLICATION OF TUXEDA SWING JOINT TO A HYDRAULIC PRESS

Another feature of the internal construction is the complete protection of the packing from wear. The packing remains stationary in the joint, protected on top and bottom by wear-protecting glands or washers. Thus the turning spindle exerts its wearing effects on the wearing rings, and not on the packing, with the exception of the inner cylindrical surface of the packing. It is stated that because of this elimination of wear Tuxeda Swing Joints have operated continuously for periods from 1 to 2 yr. without need of repacking.

Only such proper pressure as is necessary to hold a tight joint is exerted upon the packing. No destructive pressures can be applied by tightening of the gland, which also greatly adds to the life of the joints. When repacking is necessary, it can be accomplished in a few minutes without disturbing the connecting piping.

The manufacturers are Franklin Williams, Inc., 39 Cortlandt St., New York.

Novel Method of Shipping Large Transformers

THE Westinghouse Electric & Manufacturing Co., in shipping from East Pittsburgh three 7500-kv.a. water-cooled transformers for the Northern States Power Co., St. Paul, Minn., used a novel method of skidding and packing the transformers. The weight of the

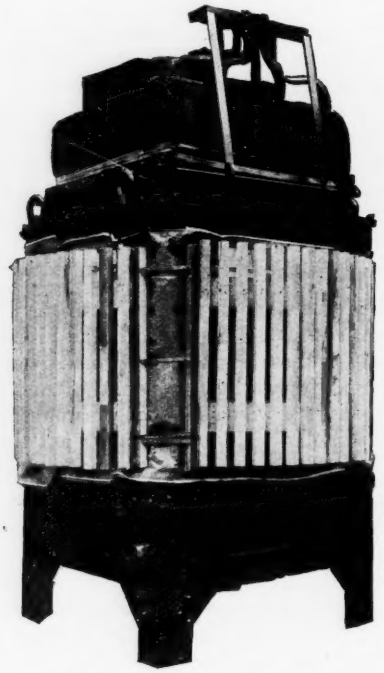

FIG. 1. METHOD OF PREPARING TRANSFORMER FOR SHIPPING

transformer without oil is approximately 45,000 lb. Figure 1 shows the transformer proper ready to place in the tank. With a corset of wooden slats and ribs of

steel, the transformer has been built up to a circular shape to fit the tank. The cooling coils were left fastened to the transformer cover and a bracing arrangement through the center of these coils against the top of the cover, which was in turn braced against the end of the car, served to hold the transformer in place inside the tank.

These transformers were so large that, even when loaded on a special drop-frame car, if shipped in the

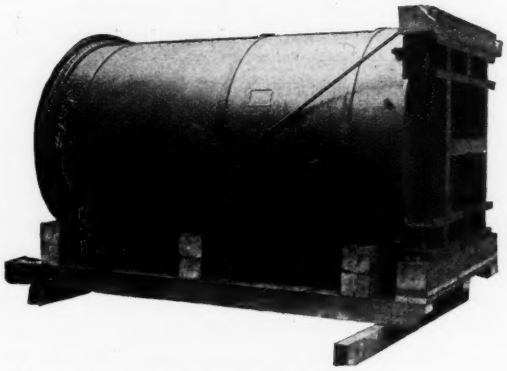

FIG. 2. TRANSFORMER IN CRADLE READY FOR SHIPMENT

upright position, they would barely be within the maximum height allowable by railroad bridges, etc., by placing a special flat cover on the tank. It was found that if the transformers were to be shipped in this manner there would be difficulty in getting them over the street at destination and up a rise of about 30 ft. without crushing through the streets or tipping over. It was

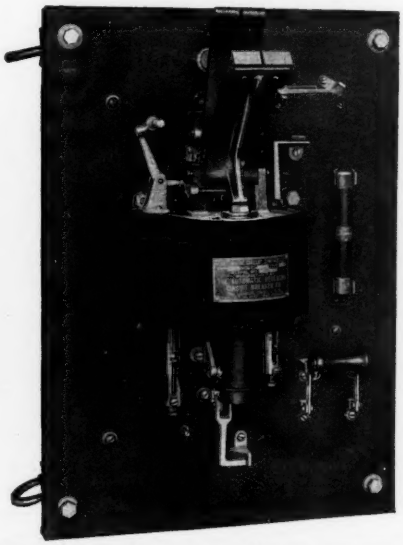

FIG. 1. TYPE C N AUTOMATIC RECLOSING CIRCUIT BREAKER

therefore suggested that, if possible, the transformers be shipped lying on their sides.

The Westinghouse company has an ingenious cradle in which to place transformers when they are to be turned over on their sides. The cradle consists of a platform with one side projecting up at right angles to the floor of the platform. At the corner of this platform there is a rocker. Attached to the top of the side and to the outer edge of the platform, are chains of equal length which, after the transformer is placed on the platform, are attached to a crane. The crane starts lifting and the chain attached to the platform is, of course, the one that carries the weight. This starts to tip the cradle on the rocker and when the cradle is just half tipped, both chains bear the weight. As the transformer goes on over in the cradle, the chain attached to the top of the side, of course, bears the weight and the one attached to the platform is slack. By this means there is no rough jostling at all in tipping the transformer.

The engineers on the job asked whether it would be possible to build a cradle arrangement similar to the above, for each transformer and use it as a skid in shipment, and in moving the transformer over the street and up the rise, at destination. These were designed and built and the transformers started on their way.

The transformers arrived in good condition, were skidded to position, as described, in the basement of the substation in St. Paul. Through a hole in the main floor of the substation a stationary hoist lifted the transformer out of the tank, the packing was removed, the transformer again lowered into the tank, the oil put in the tank and each unit was lifted up on the main floor and put into service.

Improved Automatic Reclosing Circuit Breaker

IN MINES and industrial plants there are many motor installations considerable distance from the main switchboard, consequently the motors are ordinarily started and stopped by men who are not familiar with motor operation. Many times these motors are run constantly and if stopped by a momentary failure of the line with ordinary starting equipment, an attendant must be on hand to close the starting switch when the line is cleared.

It is for such installations that an improved form of automatic reclosing circuit breaker, known as type C N, has recently been developed by the Automatic Reclosing Circuit Breaker Co. These breakers are provided with a low voltage lockout arrangement so that

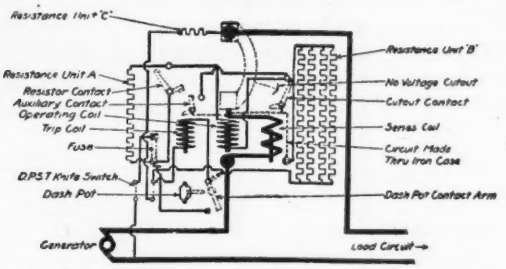

FIG. 2. DIAGRAM OF IMPROVED CIRCUIT BREAKER

when breaker is opened either by an overload current or by voltage failure, the breaker cannot reclose until the trip coil has operated.

The trip coil can be adjusted so that it will not operate except when the voltage has been restored to 50 per cent or more of normal value and the load circuit by wires being together or by starting controllers being left in the running position, etc.

Breakers are built for 110, 250 and 600-v. d. c. circuit.

Machinery War Convention

THE problem of manufacturing and supplying machinery and tools sufficient for the carrying out of the government program for the production of ships, shells, guns and aircraft will be the subject considered at the great "War Convention" of the machinery, tool and supply industry of the country to be held in Cleveland the week of May 13.

One thousand men who are bearing the brunt of the unprecedented demand for machinery will gather from all parts of the country to lay out a plan, with the aid of the government officials, to keep the great munition program going at top speed. This convention will be a joint meeting of four great national associations, the American Supply & Machinery Manufacturers' Association, the National Supply & Machinery Dealers' Association, the Southern Supply & Machinery Dealers' Association and the National Pipe & Supplies Association, which will meet together in order to co-ordinate their efforts toward one goal, "More Ships, More Shells."

"No industry has a greater responsibility at this moment than the machinery men," said H. W. Strong, president of the National Supply & Machinery Dealers' Association. "We must have men, but behind the men must be ships and munitions, and behind the ships and munitions, machinery — more machinery — still more machinery. We are in this fight to a finish. The Germans have convinced us that the only way out of the war is straight through and the American machinery industry is ready to carry on to a knock-out."

The part played by drills in the game of war is shown by the computation that 70 drilled holes are required in every 3-in. shrapnel shell; in every rifle, 90; machine gun, 350; torpedo, 3466; war plane, 4089; war truck, 5946; war ambulance, 1500; 3-in. field gun, 1280; gun caisson, 594; and anti-aircraft gun, 1200.

News Notes

FOR THE Third Liberty Loan a special committee for the machinery and machine tool trades for the New York District will have headquarters at 334 Fourth Ave., New York City. The officers of this committee are: J. W. Lane, chairman; R. L. Patterson, vice-chairman; Chas. B. Houston, secretary; Norman Dodge, director of speakers; Chas. A. Hirschberg, publicity director. The postal address is Box 43, Madison Square Station, New York, N. Y.

C. R. MATHENY has become associated with the Republic Flow Meters Co. of Chicago, Ill. After graduating from South Dakota College in 1909, he spent 14 mo. with the General Electric Co. at Schenectady in a test course and 6 mo. in charge of turbine water rate tests. A year was spent in engineering and sales with the Flow Meter Department, then 3 yr. as meter specialist in the Chicago District. For the next 3 yr. Mr. Matheny was with Briggs & Stratton, of Milwaukee, manufacturing automobile specialties, and on Mar. 1 he accepted a position with the Republic Flow Meters Co., thus returning to his earlier field of activity.

HENRY D. JACKSON, formerly of Timothy W. Sprague and Henry D. Jackson, consulting engineers, 88 Broad St., Boston, Mass., has joined the organization of Monks & Johnson, engineers and architects, 78 Devonshire St., Boston, as power engineer, taking charge of their power plant and heating work.

THE YOUNGSTOWN OFFICE of the H. W. Johns-Manville Co. is now located at 520 Market St., Youngstown, Ohio.

Books and Catalogs

THE CALORIFIC POWER OF FUELS, by Herman Poole; third edition rewritten by R. T. Kent; New York, 1918; 267 pages, 6 by 9 in.; illustrated; price $3.00.

Since the second edition of this book by the late Mr. Poole was published in 1900, there have been many advances made in the subject. Several new fuels have come into industrial use, research work by scientists has been aided by more accurate instruments and different methods of investigation have been devised. The book has, therefore, been practically rewritten, preserving, however, almost intact the original tables of the author except where proved inaccuracies were discovered. The researches of the Geological Survey of the Bureau of Mines form an addition to the original data. Earlier editions were based on the metric system while the present edition is based largely on the English system of units.

Following is a list of the subjects of chapters which will give an idea of the scope of the field covered:

Fuels, Calorimeters, Calorimeters with Constant Pressure, Calorimeters with Constant Volume. The Calorimetric Bomb Adapted to Industrial Use by Mahler, Ice Calorimeters, Solid Fuels, Liquid Fuels, Gaseous Fuels, The Combustion of Coal, Calorific Power of Coal Burned Under a Steam Boiler, and Analysis and Measurement of the Products of Combustion. In an appendix are given the boiler test code and tables.

This book will be found of great aid to all fuel users in selecting, testing, and using fuels, but is of special value to specializing in fuel testing.

UNTIL RECENTLY, nearly all coal used on locomotives was mine-run—the entire unscreened product of the mines. In the past few years, however, increasing quantities of screened lump coal have been used in locomotive service. This increase in the consumption of lump coal has been due partly to the belief that lump coal, when burned on a locomotive, produces enough more steam than mine-run coal to compensate for its greater cost. Special considerations, such as the desire to lessen the amount of smoke formed, have also led in some instances to the use of lump coal, which is generally believed to require less skill in firing than mine-run coal. The introduction of the mechanical stokers for locomotives has resulted in the use of increasing amounts of various sizes of screenings. Thus far there has been little use of such sizes as egg, egg-run, and nut coal on locomotives, although traffic and market conditions occasionally make it feasible and desirable to use them.

The relative values of several sizes of coal for locomotive use have not been well understood since most laboratory and road tests have been made with mine-run or occasionally with lump coal, and the data are inadequate and conflicting.

A series of tests to determine the value of different sizes of coal has been conducted by the Engineering Experiment Station of the University of Illinois under a cooperative agreement with the International Railway Fuel Association and the U. S. Bureau of Mines. A Mikado locomotive weighing 142 tons, belonging to the B. & O. R. R. was used, the tests being made in the locomotive laboratory at Urbana. The results are published in bulletin No. 101, entitled "Comparative Tests of Six Sizes of Illinois Coal on A Mikado Locomotive," by E. C. Schmidt, J. M. Snodgrass, and O. S. Beyer, Jr. Copies may be had without charge by addressing the Engineering Experiment Station, Urbana, Ill.

BULLETIN No. 119, just issued by the Diamond Power Specialty Co., is a handsome 48-page review of current mechanical soot blower practice. The bulletin is printed in two colors throughout, and contains in addition to many fine illustrations much data on boiler room efficiency, going into detail regarding the necessity of equipping boilers with soot blowers of the highest operating efficiency to be obtained. Charts, tables and illustrations make very clear the method of cleaning, and also show how the Diamond system is applied to boilers of different types. An extensive treatise on Insuluminum, the new metal with heat resisting properties at 1800 deg. F. is included. It is insuluminum that has made possible and successful the installation of Diamond Soot Blowers in the hottest passes of water tube boilers. Venturi nozzles through which the steam is projected between the boiler tubes are also discussed, and tables and graphs show the comparative efficiency of nozzles

of this type compared to nozzles of different sections. The company will be pleased to furnish a copy of the bulletin upon request.

WHEELER CONDENSER & ENGINEERING CO., Carteret, N. J., announces that the fourth edition of its handbook, entitled "Steam Tables for Condenser Work," is now off the press, making a total of 20,000 copies.

One reason why this handbook has met with such success is that the pressures below atmosphere are expressed in inches of mercury referred to a 30-in. barometer. Another is that it is complete. It includes a discussion of the mercury column, the errors in such measurements, and constants for their correction.

A complimentary copy of the handbook will be furnished on request to those in responsible positions who are not yet provided with a copy and who deal with steam and its many problems.

WASTE FOR WIPING has been considered as "just waste" in the past, and without much thought as to its uniformity or quality. It has remained for the Royal Mfg. Co. to treat waste as a real material, to grade it and make sure that every customer gets always the same kind of material, of uniform weight and satisfactory service.

In the plant of this company the greatest care is taken to secure these results, every batch of waste being sampled and compared with previous batches of the same grade, and this sample being kept for comparison with future batches of like quality. Twelve grades, six white and six colored, are carried, the waste received from mills being sorted accordingly and hand picked. A description of how this is done is contained in the catalog "Producing the Fittest in Waste," which shows the processes in the plant, and which can be had by writing to the Royal Mfg. Co., Rahway, N. J., and mentioning Power Plant Engineering.

A NEW FOLDER discussing Economy renewable fuses and Drop Out renewable links, has been received from Economy Fuse & Mfg. Co., of Chicago.

HOWARD guided and plain expansion joints are illustrated and described in Catalog K. J., of Howard Iron Works, Buffalo, N. Y.

AN INTERESTING circular on Yarway adjustable spray heads comes from the Yarnall-Waring Co., of Philadelphia, Pa. It shows the arrangement of spray ponds for cooling condensing water and the details of the Yarway spray head which can be adjusted to give from a fine mist to a shower of drops.

FROM THE Manistee Iron Works Co., Manistee, Mich., we have received a catalog entitled "The Pump that 'Manistee' Builds," which has several unique features. It shows the complete pump, and, by a series of overlays which turn back, starts from one end of the pump and shows exactly what would appear in taking off different parts in the process of dismantling. First, taking off the end cap at one end of the shaft,

the thrust bearing is revealed; then by taking off this and the shaft bearing, the gland and lock nuts for the sleeve are found; next, the end of the casing is removed, showing the impeller and the diffuser; then the shaft is withdrawn with the impeller, showing the diffuser and interior of the pump; by removing the diffuser and rotating element, the interior of the casing is left for inspection. All these different views are clearly shown by the ingenious arrangement of the overlays. The balance of the catalog shows diagrams indicating the performance of the pump, and explains the details of construction of the Rees-Roturbo unit.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC.

required by the Act of Congress of August 24, 1912, of Power Plant Engineering, published Semi-Monthly at Chicago, Ill., for April 1, 1918.

State of Illinois } ss.
County of Cook }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Chas. Sanford Clarke, who, having been duly sworn according to law, deposes and says that he is the Secretary of Power Plant Engineering, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse side of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Name of— Post-Office Address—
Publisher, Technical Publishing Co., 537 S. Dearborn St.
Editor, Arthur L. Rice, 537 S. Dearborn St.
Managing Editor, Arthur L. Rice, 537 S. Dearborn St.
Business Manager, E. R. Shaw, 537 S. Dearborn St.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)

E. R. Shaw, 537 S. Dearborn St.
Arthur L. Rice, 537 S. Dearborn St.
Chas. S. Clarke, 537 S. Dearborn St.
C. B. Leech, 935 R. E. Trust Bldg., Philadelphia, Pa.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)

There are none.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other persons, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is.....

(This information is required from daily publications only.)

Chas. Sanford Clarke, Sec'y.

Sworn to and subscribed before me this 26th day of March, 1918. Warren A. Lathrop, Notary Public.

(SEAL) (My commission expires October, 1918.)

NOTE.—This statement must be made in duplicate and both copies delivered by the publisher to the postmaster, who shall send one copy to the Third Assistant Postmaster General (Division of Classification), Washington, D. C., and retain the other in the files of the post office. The publisher must publish a copy of this statement in the second issue printed next after its filing.

POWER PLANT ENGINEERING

Trade-mark, Reg. U. S. Pat. Off.
(Established over 22 years.)
PUBLISHED THE FIRST AND FIFTEENTH OF EACH MONTH

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Three line parallel 3-point border rule used.

Stippled plates used, but no heavy, black and white plates.

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Per line, 30 cents each insertion.

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No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy and cuts should be received at Chicago Office eighteen days prior to date of publication.

Circulation of this issue, 23,700.

Technical Publishing Company

537 S. Dearborn Street
Chicago

Position Wanted

POSITION WANTED—Power station draftsman, electrical graduate, experienced in power and substation layout work. Six years in present position with large manufacturing concern. Desires change. Address Box 511, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 4-15-1

POSITION WANTED—By a practical high- and low-pressure pipe fitter. Age 35 years. Would like to become connected with reliable concern as general pipe fitter or foreman. Address Box 512, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 3-1-5

POSITION WANTED—by a competent electrician and engineer; 34 years of age; married; strictly sober and energetic. Willing to take complete charge of electric light plant or will take charge of power installation or operation. Present salary $150. Desire change with larger opportunity. Address Box 515, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 3-15-4

POSITION WANTED—As chief engineer, 13 years' experience with Corliss and high-speed engines, electrical and refrigerating machinery. Sober and reliable. Best of references. Address Box 518, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 4-1-2

POSITION WANTED—By middle aged man and chief engineers' license. Can handle d.c. and a.c. machinery, steam boilers, gas and oil engines. Also experienced in wiring and repair work. Address Box 508, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 2-15-6

POSITION WANTED—By an engineer with 13 years' experience with boilers, engines, electrical and refrigerating machinery. Wishes to connect with a permanent, reliable concern. Am familiar with flue gas analyzing instruments and furnace efficiency methods. Address Box 509, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 2-15-4

POSITION WANTED—To take charge of plant as superintendent. A1 electrician. Salary $150. For further particulars write Box 520, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 4-3-1

POSITION WANTED—By electrician, experienced with modern wiring, meter testing and reading. Best of references, 4 years' experience. Will go anywhere. Address Carl H. Menke, 715 W. Commercial St., Kahoka, Mo. 4-15-1

POSITION WANTED—As engineer in small plant by young man. Over 5 years' experience in grain elevator. Steady and sober habits. Good mechanic. Write R. Siebke, Walcott, Iowa. 4-15-2

POSITION WANTED—By a first class man, aged 35, married, strictly sober, reliable and energetic. For the past 7 years superintendent of water, light and power plants, capable of doing any kind of work in steam or electrical engineering, meter repairing or testing, line work or inside wiring. Especially capable of managing water and light plant properties. Prefer a field where there is a chance of advancement. Address Box 522, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 5-1-2

POSITION WANTED—By engineer and electrician, 25 years experience with engines and water-powers, 15 years with a.c. and d.c. machinery. Good reference, if you can use me write H. A. Albert, Ansley, Neb. 5-1-1

Help Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, O.; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Power Plant Engineer, 537 S. Dearborn St., Chicago, Ill. tf

WANTED—A competent refrigerating engineer in Western Pennsylvania. Must be familiar with raw water and ice making system and electric machinery. State salary wanted. Address Box 505, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf

WANTED—A competent electric light engineer, familiar with Corliss engines, 12-hour shift. Good working conditions. Salary $85.00. Fuel consumption 2½ tons per shift. No boiler washing. Address L. F. Haupt, superintendent, Prairie du Chien, Wis. tf

WANTED—Engineer to take charge of 12-ton ice machine and small eletrical equipment, all of which is high grade. A steady and lasting position for a clean, sober man. Salary $100. Write Andrew Lohr Bottling Works, Cairo, Ill. 5-1-2

Wanted

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial to put it to test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, O. tf

WANTED—Agents handling engine and boiler room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Box 381, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf

WANTED—Marine boilers. We will pay cash awards for information that leads to a purchase by us of marine boilers of from 75 hp. to 250 hp. The Pittsburg Boiler & Machine Co., Pittsburg, Kan. tf

WANTED—Agents handling engine and boiler room specialties in every section of our Boiler Girth Seam Protector. Liberal inducements. Give experience and territory covered. Address National Boiler Protector Co., Dayton, Ohio. tf

WANTED—Engineers in their spare time and salesmen who carry side lines and visit engineers to sell the Selden and Zena packings. Both packings have shown their worth by use in largest plants. Randolph Brandt, 70 Cortlandt St., New York. 3-15-6

AGENTS WANTED—Salesmen calling on power plants to handle established nationally advertised product backed by a direct-by-mail campaign that "follows through" liberal commission. Write today for our proposition. Box 521, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 4-15-2

WANTED—Agents who call upon engineers to sell positively the best pump valve on the market. Commission basis. Excellent. Address Box 500, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 5-1-2

For Sale

FOR SALE—One Dexter valve reseating outfit No. 6 TL for ¼ to 6 inches. One boiler maker screw punch 11/16 die. F. C. Hale, 216 Ft. Wayne Ave., Richmond, Ind. 5-1-1

FOR SALE—125 volt direct connected units.

K.W.	Generator	Engine	Price
100	G. E.	Harrisburg	$1750
75	G. E.	Harrisburg	1600
50	G. E.	Harrisburg	1350
15	C. W.	Armington & Sims	450

Power Machinery Exchange, Jersey City. tf

Patent and Patent Attorneys

PATENTS THAT PROTECT AND PAY — Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent lawyer, 624 F St., N. W., Washington, D. C. tf

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact costs. Send for full information. tf

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf

Technical Books

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers for Power Plant Engineering. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Subscription Department, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill.

Miscellaneous

FACTORY MANAGERS, ENGINEERS AND OWNERS —Coal is high and scarce. Let us tell you how to conserve it and utilize your exhaust steam for heating and drying purposes. Address Monash Engineering Co., 1413 W. Jackson Boulevard, Chicago, Ill. tf

DEBTS COLLECTED QUICKLY!—Established 25 years same address. William H. Dodd, 87 Nassau St., New York, N. Y. 5-1-2

Sparks From The Advertising Pages

Where Buyers and Sellers Meet

Twenty-Four Regiments Carry On

Over the world two mighty forces brood. In the cloud banks that drift around their knees thousands of wasp-like figures, dart, and sting, and fall to earth; in the cause of one or the other of these.

About their feet millions of tiny shapes charge, and die, and stumble, and fight on; that one or the other of these brooding shapes may triumph.

Now we know that every man, every woman, every child, and children yet unborn, will live, perish, survive or be ground to dust by the benignant or malignant triumph of one or the other of these forces of the universe.

These two shapes cannot much longer survive together on this planet. Which shall it be—Liberty or Slavery?

Howitzer to howitzer, machine gun to machine gun, bayonet to bayonet, man to man, these human midgets fight—"over there."

Man to man, farmer against farmer, housewife against housewife, machinist against machinist—the fight goes on back of the lines.

Twenty-four thousand of us—two army divisions—who read these pages are handling power plants. Our hands on the throttle of industry over here, we, man to man, regiment against regiment, are fighting against the army divisions of power plant men in the line back of the line our boys are facing.

We walk freely to our daily task; our heads erect, fearing no man.

They are driven to their daily task by the mailed fist.

Through rifts in the pall of smoke and dust from bursting shell and crumbling towers, we catch an occasional glimpse of those power plant men who oppose us—in Essen, in Hamburg, in Berlin.

We read of their wonderful efficiency. And we read of men locked in plants for months at a stretch. We read of engine-room crews driven to their tasks with the lash of the foreman on their bare backs.

To oppose this "made in Germany" efficiency we must create a greater efficiency. To oppose the discipline of the lash we must bring a greater discipline of freedom.

How shall we do it? By the superior intelligence of our effort and by the superior quality of our armament.

POWER PLANT ENGINEERING is out to help these twenty-four regiments of American engineers in their fight against the driven men of Kaiserdom.

In its editorial pages it strives to give them every possible aid to the intelligence of their effort; in the advertising pages it offers them the best in equipment.

Here is displayed your armament; the superior boilers, engines, piping, unions, valves, packing and testing instruments that are the artillery, machine guns, rifles, pistols and spy glasses to make your intelligent effort most effective.

Arm yourself and fight—for Liberty.